تعليم

Academic Year العام الدراسي	2024/2025
Term الفصل	3
Subject المادة	Physics/Inspire الفيزياء/انسباير
Grade الصف	10
Stream المسار	Advanced المتقدم
Number of MCQ عدد الأسئلة الموضوعية	15
Marks of MCQ درجة الأسئلة الموضوعية	4

$EMF = BLv\sin\theta$	effective current $I_{eff} = \left(\frac{\sqrt{2}}{2}\right) I_{max}$	effective potential $V_{eff} = \left(\frac{\sqrt{2}}{2}\right) V_{max}$
average power $P_{AC} = \frac{1}{2} P_{AC\ max}$	Power P = IV	$\frac{I_s}{I_p} = \frac{V_p}{V_s} = \frac{N_p}{N_s}$

$I = \frac{EMF}{R}$	Turns ratio $= \frac{N_s}{N_p}$	$P_P = I_P V_P$ $P_S = I_S V_S$
$c = \lambda f$	$v = \lambda f$	$v = \frac{c}{\sqrt{k}}$
Speed of light in vacuum $3 \times 10^8\ m/s$	$c = 10^{-2}$ $m = 10^{-3}$ $\mu = 10^{-6}$ $n = 10^{-9}$	

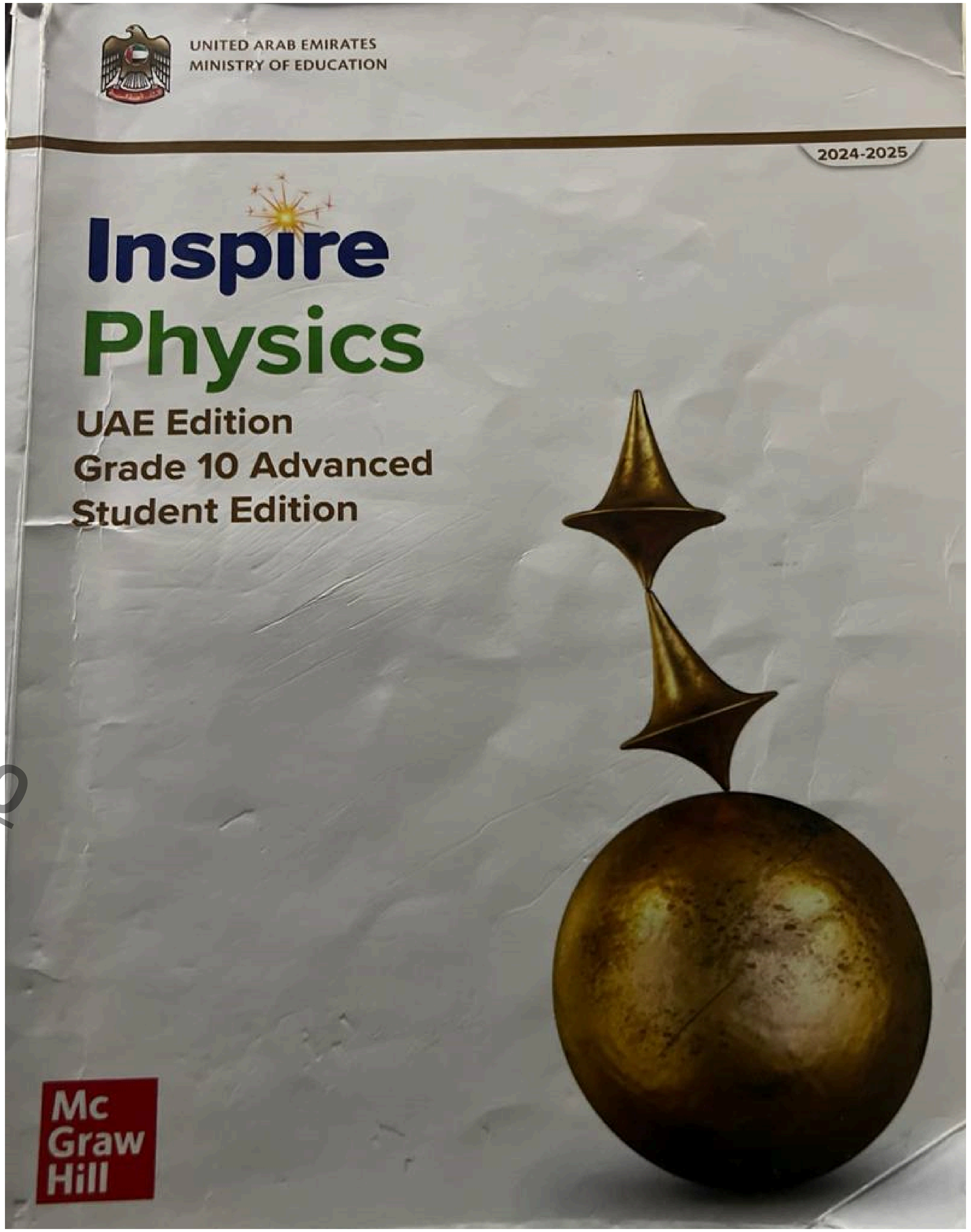
Thin film $2d = \left(m + \frac{1}{2}\right)\left(\frac{\lambda}{n_{film}}\right)$		$2d = m\lambda_{film}$	$\lambda_{film} = \frac{\lambda_{vacuum}}{n_{film}}$
Single slit $2x_1 = \frac{2\lambda L}{w}$	Double slit $\lambda = \frac{xd}{L}$	$c = 10^{-2}$ $\mu = 10^{-6}$	$m = 10^{-3}$ $n = 10^{-9}$

Whenever necessary, use the following physical formulas.
كلما كان ذلك ضروريا، استخدم الصيغ الفيزيائية التالية

Unit 6 (Module 21) Electromagnetism الكهرومغناطيسية	$EMF = BLv\sin(\theta)$ $I = \frac{EMF}{R}$ $P_{AC} = \frac{1}{2}P_{max}$ $I_{eff} = \left(\frac{\sqrt{2}}{2}\right) I_{max}$ $\lambda = \frac{v}{f} = \frac{c}{f}$		$P = \frac{(\Delta V)^2}{R}$ $(P_p = P_s)_{ideal\ transformer}$ $\frac{I_s}{I_p} = \frac{V_p}{V_s} = \frac{N_p}{N_s}$ $V_{eff} = \left(\frac{\sqrt{2}}{2}\right) V_{max}$ $v = \frac{c}{n} = \frac{c}{\sqrt{k}}$
Unit 7 (Module 17) Interference and Diffraction التداخل والحيود	$m\lambda = \frac{x_m d}{L}$, $m = 0,1,2,\ldots$		$\lambda_{film} = \frac{\lambda_{vacuum}}{n_{film}}$
	Two-wave mode and interference type وضعية الموجة ونوع التداخل	One wave is inverted إحدى الموجتين مقلوبة	Either both waves OR none are inverted كلا الموجتين مقلوبة أو غير مقلوبة
	Constructive interference تداخل بناء	$2d = (m + \frac{1}{2})\lambda_{film}$ $m = 0, 1, 2, \ldots$	$2d = m\lambda_{film}$ $m = 1, 2, 3 \ldots$
	Destructive interference تداخل هدام	$2d = m\lambda_{film}$ $m = 1, 2, 3 \ldots$	$2d = (m + \frac{1}{2})\lambda_{film}$ $m = 0, 1, 2, \ldots$

Whenever necessary, use the following physical constants.
كلما كان ذلك ضروريا، استخدم الثوابت الفيزيائية التالية

$c = 3 \times 10^8\ m/s$	$g = 9.81\ m/s^2$



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Hamad alabdolly حمد العبدولى

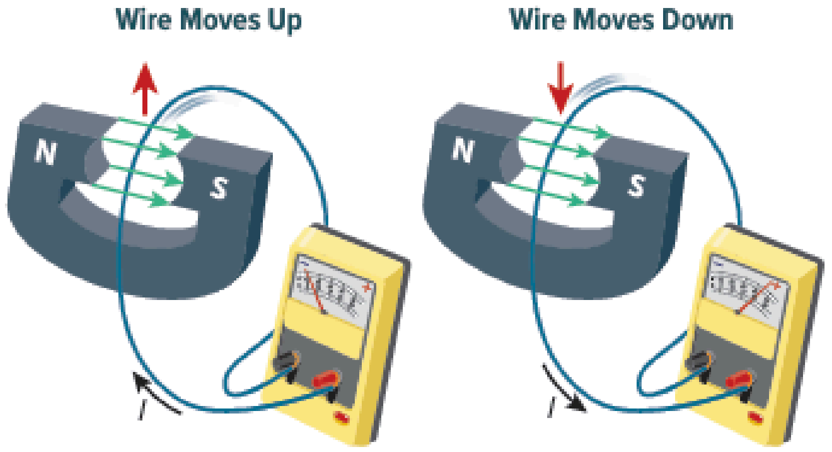
1	Explain how the relative motion between a conductor such as a wire and a magnetic field causes an induced emf.	Student Book	P.(148 - 150)
		Q.(1 - 3)	P.151

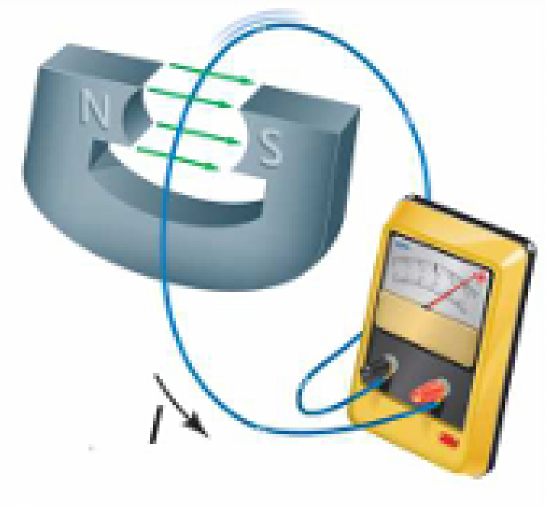
PG:148

Changing Magnetic Fields

Following Oersted's discovery that a current produces a magnetic field, Michael Faraday became convinced the reverse was possible: that a magnetic field could produce a current. In 1822 he wrote this goal in his notebook: "Convert magnetism into electricity." After ten years of unsuccessful experiments, he succeeded. He induced a current in a circuit by moving a wire through a magnetic field. In the same year in America, Joseph Henry, a high-school teacher who later became the first secretary of the Smithsonian Institution, made the same discovery. **Figure 1** illustrates a modern version of one of Faraday's and Henry's experiments.

Relative motion An electric current can be generated in a wire in a circuit when at least part of the wire moves through, and cuts, magnetic field lines. Field lines can be cut when a segment of wire moves through a stationary magnetic field, as the wire does in **Figure 1.** Field lines also can be cut when a magnetic field moves past a stationary wire or when the strength of a magnetic field changes around a wire. Electromagnetic induction is the process of generating current through a wire in a circuit in a changing magnetic field.





يُبيّن الشكل سلكاً يتحرك في مجال مغناطيسي فيتولد فيه تيار كهربائي مستحث.
في أي اتجاه يتحرك السلك؟

The figure shows a wire moving in a magnetic field so an induced current passes through it.
In which direction is the wire moving?

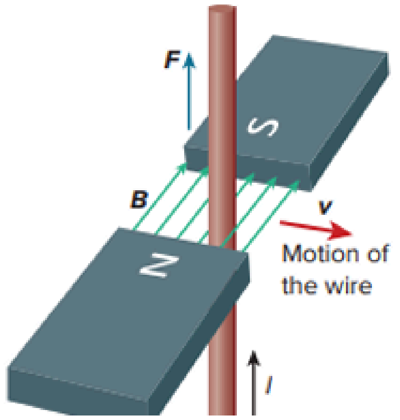
The wire is moving downwards perpendicular to the magnetic field.	السلك يتحرك إلى الأسفل عمودياً على خطوط المجال.
The wire is moving upwards perpendicular to the magnetic field.	السلك يتحرك إلى الأعلى عمودياً على خطوط المجال.
The wire is moving in the direction of the magnetic field lines.	السلك يتحرك في اتجاه خطوط المجال.
The wire is moving opposite to the magnetic field lines.	السلك يتحرك بعكس اتجاه خطوط المجال.

1	Explain how the relative motion between a conductor such as a wire and a magnetic field causes an induced emf.	Student Book	P.(148 - 150)
		Q.(1 - 3)	P.151

2	1. Explain how the relative motion between a conductor such as a wire and a magnetic field causes an induced emf. 2. Apply the right-hand rule to determine the direction of the induced emf and thus the direction of induced current in a wire moved in a magnetic field.	Student Book	P.149
		Figure 2	P.149

6	Define electromotive force emf and specify its unit as volts (V).	Student Book	P.149
		Content	P.149

Induced *EMF* You don't need a chemical reaction in a battery to create an *EMF*. When a wire moves perpendicular to a magnetic field, there is a force on the charges in the wire. The force causes negative charges to move to one end of the wire, leaving positive charges at the other end. This separation of charge produces an electric field and therefore a potential difference across the length of the wire. This potential difference is called the **induced electromotive force,** or induced *EMF*.



The unit of induced electromotive force (EMF) is the

وحدة القوة المحركة الكهربائية (المستحثة) هي :

A	Volt	B	Newton	C	Tesla	D	Ohm

أي من التالي يمثل وحدة صحيحة لقياس (EMF)؟

Which of the following is a correct unit for (EMF)?

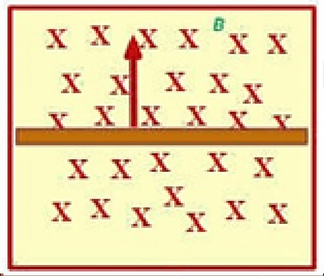
$\frac{T.A}{m.s}$ $\quad J.C \quad$ $\frac{J}{C^2}$ $\quad$ $\frac{N.m}{A.s}$

. The force causes negative charges to move to one end of the wire, leaving positive charges at the other end. This separation of charge produces an electric field and therefore a potential difference across the length of the wire. This potential difference is called the **induced electromotive force,** or induced *EMF*.

$$\left(\frac{N}{A \cdot m}\right)(m)\left(\frac{m}{s}\right) = \frac{(N \cdot m)}{(A \cdot s)} = \frac{J}{C} = V$$

in which direction would the electric field in the wire point if the wire were pulled to the upword

حدد اتجاه المجال الكهربائي الذي سيتولد في السلك إذا تم تحريك السلك للاعلى

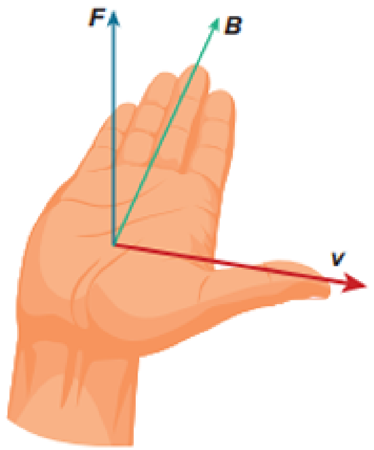


A	Up word للاعلى	B	Down word للاسفل
C	Right لليمين	D	Left لليسار

Induced Electromotive Force in a Wire

EMF is equal to the strength of the magnetic field times the length of the wire times the component of the velocity of the wire in the field that is perpendicular to the field.

$$EMF = BLv(\sin \theta) \qquad I = \frac{EMF}{R}$$



If a wire moves perpendicular to a magnetic field, the above equation reduces to $EMF = BLv$, because $\sin 90^\circ = 1$. Note that no *EMF* is induced in a length of wire that moves parallel to a magnetic field because $\sin 0^\circ = 0$.

PG:150

INDUCED *EMF* A straight wire is part of a circuit that has a resistance (R) of 0.50 Ω. The wire is 0.20 m long and moves at a constant speed of 7.0 m/s perpendicular to a magnetic field of strength 8.0×10^{-2} T.

a. What *EMF* is induced in the wire?

b. What is the current through the wire?

c. If a different metal were used for the wire, increasing the circuit's resistance to 0.78 Ω, what would the new current be?

Known	Unknown
$v = 7.0$ m/s	$EMF = ?$
$L = 0.20$ m	$I = ?$
$B = 8.0\times10^{-2}$ T	
$R_1 = 0.50\ \Omega$	
$R_2 = 0.78\ \Omega$	

2 SOLVE FOR THE UNKNOWN

a. $EMF = BLv$

$$= (8.0\times10^{-2}\ \text{T})(0.20\ \text{m})(7.0\ \text{m/s})$$
$$= 0.11\ \text{T}\cdot\text{m}^2/\text{s}$$
$$= 0.11\ \text{V}$$

b. $I = \frac{EMF}{R}$

$$= \frac{0.11\ \text{V}}{0.50\ \Omega}$$
$$= 0.22\ \text{A}$$

c. $I = \frac{EMF}{R}$

$$= \frac{0.11\ \text{V}}{0.78\ \Omega}$$
$$= 0.14\ \text{A}$$

A wire of length (0.18 m) moves at a constant speed perpendicular to a magnetic field of (0.4 T) and EMF of (0.60 V) generates in the wire .What is the speed of the wire?

يتحرك سلك طوله (0.18 m) بسرعة ثابتة بشكل متعامد على مجال مغناطيسي شدته (0.4 T) فيتولد فيه EMFمقدارها (0.60 V) ما سرعة حركة السلك ؟

A	2.0 m/s	B	3.8 m/s
C	8.3 m/s	D	10 m/s

A **15 cm** length of wire is moving perpendicularly through a magnetic field of strength **1.4 T** at the rate of **0.12 m/s**. What is the ***EMF*** induced in the wire ?

يتحرك سلك طوله (15 cm) عمودياً عبر مجال مغناطيسي مقداره (1.4 T) بسرعة (0.12 m/s) . فإن EMF المستحثة في السلك ؟

A	0 V	B	0.025 V	C	0.018 V	D	2.5 V

A straight wire is part of a circuit that has a resistance (R) of 0.50 Ω. The wire is 0.20 m long and moves at a constant speed of 7.0 m/s perpendicular to a magnetic field of strength 8.0×10^{-2} T .What *EMF* is induced in the wire

سلك مستقيم يمثلّ جزءا من دائرة بمقاومة(R) تبلغ 0.50 Ω يبلغ طول السلك 0.20 m ويتحرك بسرعة ثابتة تبلغ 7.0 m/s عموديا على مجال مغناطيسي مقداره 8.0×10^{-2} T ما مقدارEMF المستحثة في السلك

A	1.1 V	B	0.11 N
C	11 V	D	0.11 V

LUAY ATA 0505369567

1	Explain how the relative motion between a conductor such as a wire and a magnetic field causes an induced emf.

Student Book	P.(148 - 150)
Q.(1 - 3)	P.151

PG:151

PRACTICE Problems

ADDITIONAL PRACTICE

1. You move a straight wire that is 0.5 m long at a speed of 20 m/s vertically through a 0.4-T magnetic field pointed in the horizontal direction.
   a. What *EMF* is induced in the wire?
   b. The wire is part of a circuit with a total resistance of 6.0 Ω. What is the current?
2. A straight wire that is 25 m long is mounted on an airplane flying at 125 m/s. The wire moves in a perpendicular direction through Earth's magnetic field ($B = 5.0\times10^{-5}$ T). What *EMF* is induced in the wire?
3. A straight wire segment in a circuit is 30.0 m long and moves at 2.0 m/s perpendicular to a magnetic field.
   a. A 6.0-V *EMF* is induced. What is the magnetic field?
   b. The total resistance of the circuit is 5.0 Ω. What is the current?
4. **CHALLENGE** A horseshoe magnet is mounted so that the magnetic field lines are vertical. You pass a straight wire between the poles and pull it toward you. The current through the wire is from right to left. Which is the magnet's north pole? Explain.

4

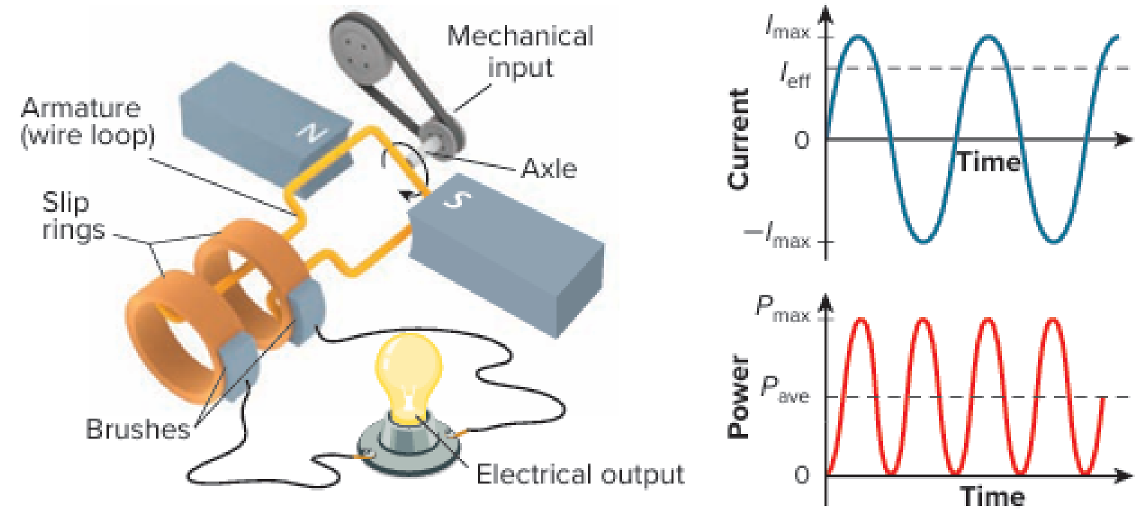
A straight wire is part of a circuit that has a resistance (R) of 0.50 Ω. The wire is 0.20 m long and moves at a constant speed of 7.0 m/s perpendicular to a magnetic field of strength 8.0×10^{-2} T .What is the current through the wire if $EMF = 0.11v$

سلك مستقيم يمثل جزءا من دائرة بمقاومة (R) تبلغ 0.50 Ω يبلغ طول السلك 0.20 m ويتحرك بسرعة ثابتة تبلغ 7.0 m/s عموديا على مجال مغناطيسي مقداره 8.0×10^{-2} T ما مقدار التيار المستحث المار خلال السلك اذا كان الجهد $0.11v$

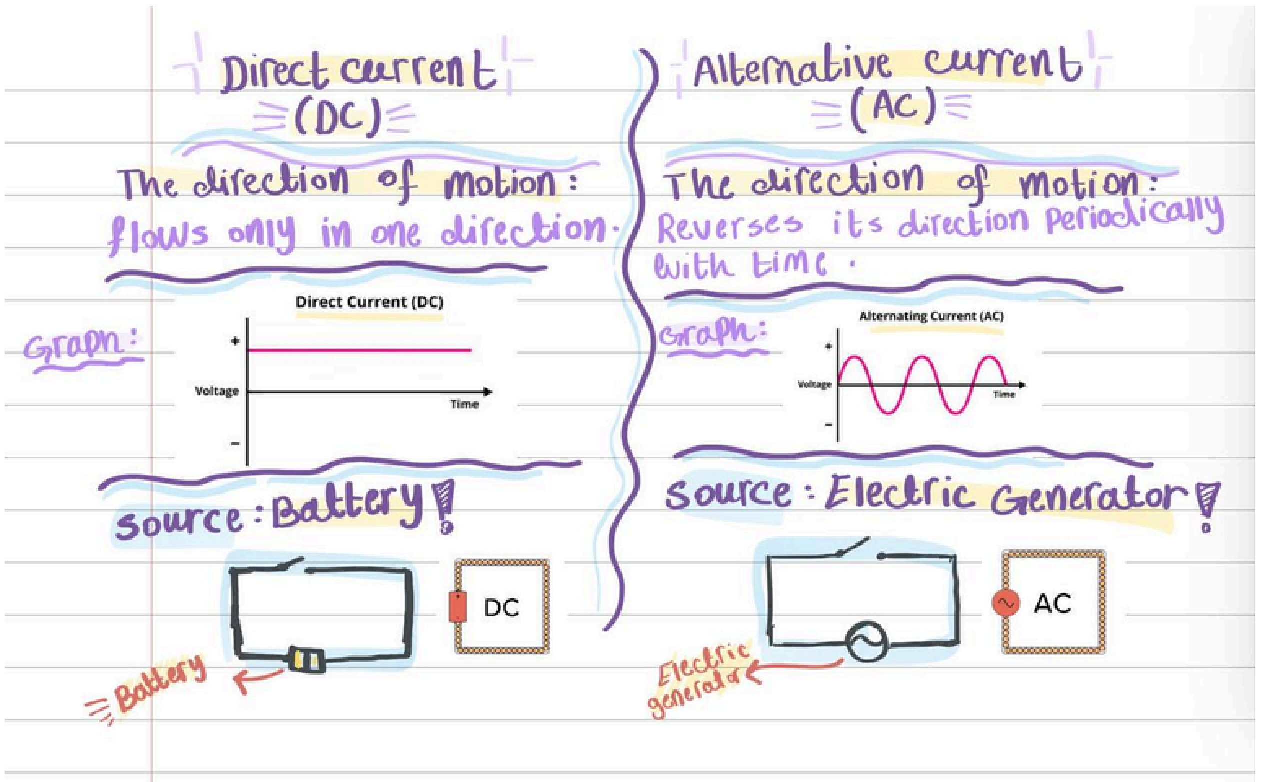
A	0.22 A	B	2.2 A
C	0.022 A	D	0.22 mA

3	Relate effective current and effective potential to the maximum values of current and potential in an AC circuit, and calculate the maximum and effective values of current, potential, and power for an AC generator.	Student Book	P.(155 - 154)
		Q.(5 – 8)	P.155

PG:154



Average power The power produced by an AC generator is the product of the current and the potential difference. Because both current and potential difference vary, the power in the circuit varies. The graph at the bottom right of **Figure 8** shows the power versus time produced by an AC generator. Note that power is always positive because I and V are either both positive or both negative. Average power, P_{AC}, is half the maximum power; thus, $P_{AC} = \frac{1}{2}P_{AC\ max}$.



the average power of an AC generator is equal:

القدرة المتوسطة لمولد تيار متردد تساوي

A	$P_{av} = 2P_{max}$	**B**	$P_{av} = 2P_{max}$
C	$Pav = -\frac{1}{2}Pmax$	**D**	$Pav = \frac{1}{2}Pmax$

LUAY ATA 0505369567

3	Relate effective current and effective potential to the maximum values of current and potential in an AC circuit, and calculate the maximum and effective values of current, potential, and power for an AC generator.	Student Book	P.(155 - 154)
		Q.(5 – 8)	P.155

PG:155

Effective Potential Difference

Effective potential difference is equal to $\frac{\sqrt{2}}{2}$ times the maximum potential difference.

$$V_{eff} = \left(\frac{\sqrt{2}}{2}\right)V_{max} = 0.707V_{max}$$

Effective Current

Effective current is equal to $\frac{\sqrt{2}}{2}$ times the maximum current.

$$I_{eff} = \left(\frac{\sqrt{2}}{2}\right)I_{max} = 0.707I_{max}$$

5. A generator develops a maximum potential difference of 170 V.

a. What is the effective potential difference?

b. A lamp is placed across the generator with an I_{max} of 0.70 A. What is I_{eff} through the lamp?

c. What is the resistance of the lamp when it is on?

6. The RMS potential difference of an AC household outlet is 117 V. What is the maximum potential difference across a lamp connected to the outlet?

7. If the average power used over time by an electric light is 75 W, what is the peak power?

8. CHALLENGE An AC generator delivers a peak potential difference of 425 V.

a. What is the V_{eff} in a circuit connected to the generator?

b. The resistance is $5.0\times10^2\ \Omega$. What is the effective current?

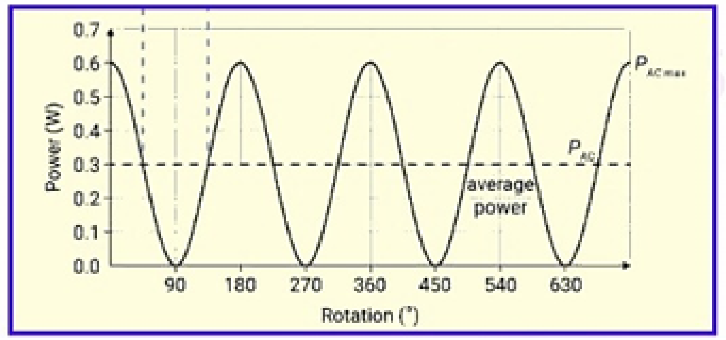
If the average power used over time by an electric light is 110 W, what is the peak power?

اذا كان متوسط القدرة التي يستخدمها الضوء الكهربائي 110 W، فما هي القدرة القصوى؟

A	55 w	B	150 w
C	75 w	D	220 w

From the figure what is the avarege power?

من الشكل احسب متوسط القدرة؟



A	0.6 w	B	0 w
C	0.3 w	D	0.4 w

If the effective value of a current passing in an electrical device is 8 A , The maximum value of the current passing through it ?

إذا كانت القيمة الفعالة لتيار يمر في جهاز كهربائي 8 A ، فإن القيمة العظمى للتيار المار فيه ؟

A	11.3 A	B	5.7 A	C	16	D	4

4	Explain how transformers are used in the National Grid System to transmit power through long distances with minimal power losses.	Student Book	P.163
		Q.(20 – 23)	P.163

PG:163

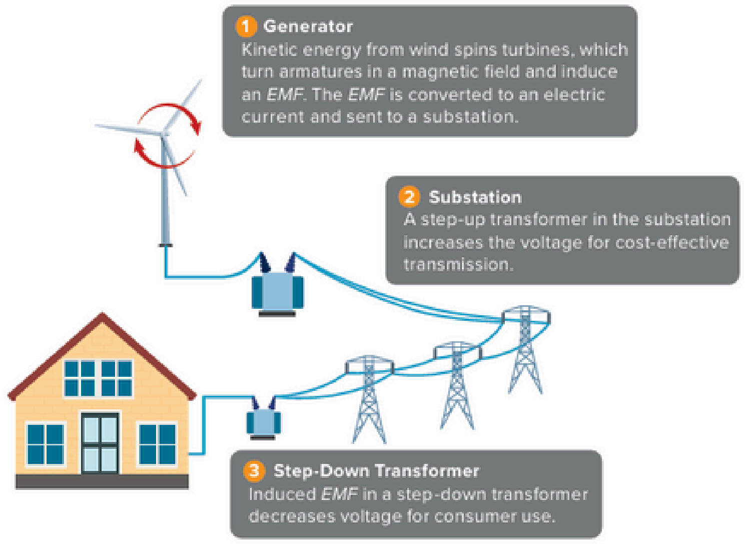
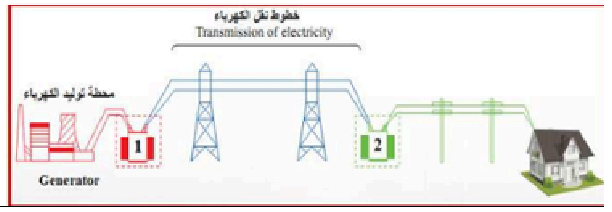


Figure 16 Step-up transformers increase potential differences (voltages) in overhead power lines. Step-down transformers decrease potential differences for consumer use.

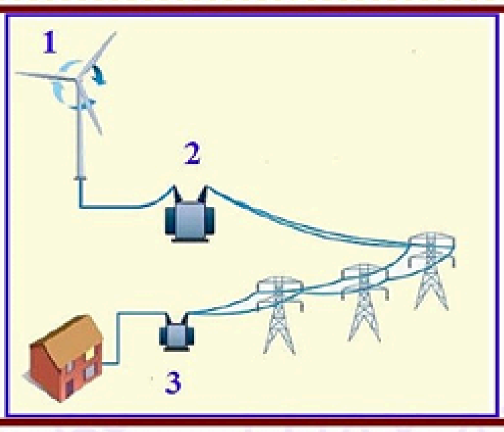
Everyday uses of transformers Long-distance transmission of electrical energy is economical only if very high potential differences are used. High potential differences reduce the current required in the transmission lines, keeping the wasteful energy transformations low. As shown in **Figure 16,** step-up transformers are used at power sources, where they can develop potential differences up to 480,000 V. When the energy reaches homes, step-down transformers reduce the potential difference to 120 V. Game systems, printers, laptop computers, and rechargeable toys have transformers inside their casings or in blocks attached to their cords. These small transformers further reduce potential differences from wall outlets to the 3 V–26 V range.

18. **Lenz's Law** You hang a coil of wire with its ends joined so that it can swing easily. If you now plunge a magnet into the coil, the coil will start to swing. Which way will it swing relative to the magnet and why?
19. **Motors** If you unplugged a running vacuum cleaner from a wall outlet, you would be much more likely to see a spark than you would if you unplugged a lighted lamp from the wall. Why?
20. **Transformers and Current** Explain why a transformer may be operated only on AC.
21. **Transformers** Frequently, transformer coils that have only a few turns are made of very thick (low-resistance) wire, while those with many turns are made of thin wire. Why?
22. **Step-Up Transformers** Refer to the step-up transformer shown in **Figure 15.** Explain what would happen to the primary current if the secondary coil were short-circuited.
23. **Critical Thinking** Would permanent magnets make good transformer cores? Explain.

Question 4: Ministry: Long distance transmission of electrical energy is economical only when keeping the wasteful energy through the transmission lines low.
The figure shows the transmission of electricity from the generator to a house. What type of transformers (1) and (2) are used for this?



b. 1)step-up transformer 2)step-down transformer	c. 1)step-down transformer 2)step-down transformer
d. 1)step-down transformer 2)step-up transformer	a. 1)step-up transformer 2)step-up transformer

Rrefer to this figure **What does 1 , 2 , 3** **Represent to :**		اعتماد على الشكل ماذا يمثل كل من 1 ، 2 ، 3
A	1: step up 2 : step down 3 : step up	1 : رافع 2 : خافض 3 : رافع
B	1: step up 2 : step up 3 : step up	1 : رافع 2 : رافع 3 : خافض
C	1: generator 2 : step down 3 : step up	1 : مولد 2 : خافض 3 : رافع
D	1: generator 2 : step up 3 : step down	1 : مولد 2 : رافع 3 : خافض

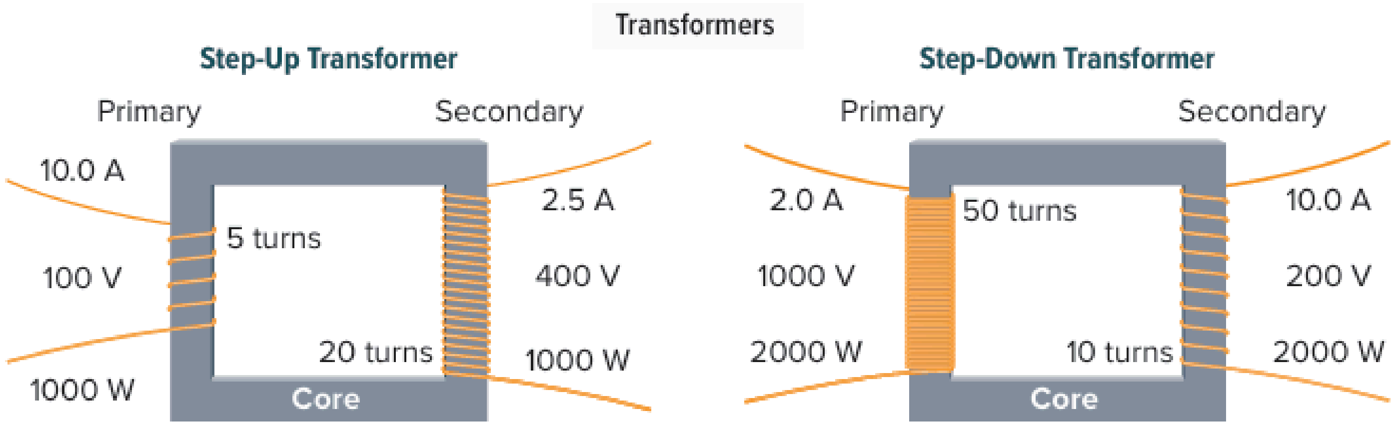
5	Relate the turn's ratio of a transformer to its corresponding voltage ratio and apply the ideal transformer equation to solve numerical problems.	Student Book	P.(160 - 161)
		Q.(16 – 17)	P.162

PG:160

If the secondary potential difference is larger than the primary potential difference, as it is in the left part of **Figure 15**, the transformer is called a **step-up transformer.** If the secondary potential difference is smaller than the primary potential difference, as in the right part of **Figure 15**, the transformer is called a **step-down transformer.**

Get It?

Compare How do step-up transformers differ from step-down transformers?



varying *EMF* and current. An *EMF* and current in one coil due to changing current in another coil is called **mutual inductance.**

PG:161-162

Transformer Equation

The ratio of the current in the secondary coil to the current in the primary coil is equal to the ratio of the potential difference in the primary coil to the potential difference in the secondary coil, which is also equal to the ratio of the number of turns on the primary coil to the number of turns on the secondary coil.

$$\frac{I_s}{I_p} = \frac{V_p}{V_s} = \frac{N_p}{N_s}$$

Step-Up Transformer	Step-Down Transformer
$V_p < V_s$	$V_p > V_s$
$I_p > I_s$	$I_p < I_s$
$N_p < N_s$	$N_p > N_s$

For the following problems, effective currents and potential differences are indicated.

16. A step-down transformer has 7500 turns on its primary coil and 125 turns on its secondary coil. The potential difference across the primary circuit is 7.2 kV. What is the potential difference across the secondary circuit? If the current in the secondary circuit is 36 A, what is the current in the primary circuit?

17. CHALLENGE A step-up transformer that is 95 percent efficient has 300 turns on its primary coil and 90,000 turns on its secondary coil. The potential difference of the generator to which the primary circuit is attached is 60.0 V. What is the potential difference across the secondary circuit? The current in the secondary circuit is 0.50 A. What current is in the primary circuit?

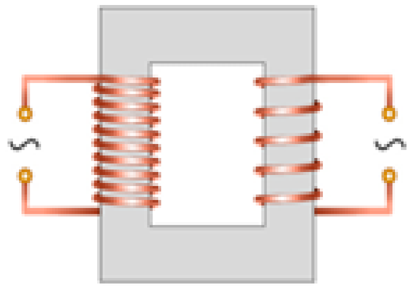
5	Relate the turn's ratio of a transformer to its corresponding voltage ratio and apply the ideal transformer equation to solve numerical problems.	Student Book	P.(160 - 161)
		Q.(16 – 17)	P.162

Question 9: **Ministry:** Look at the following transformer and answer from a to d?

The following transformer has a primary coil consists of 10 turns and a secondary coil consists of 5 turns. The primary coil is supplied with a potential difference of 100 V.

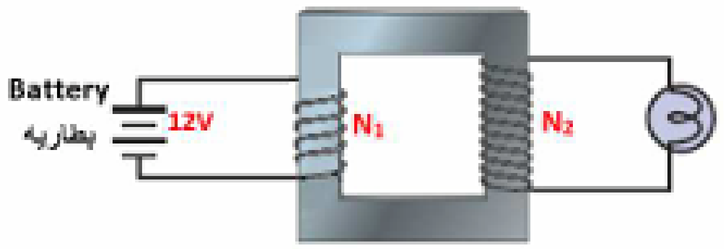
a) Which type of transformer is it?

b) What type of current are transformers used with?



c) Find the potential difference in the secondary coil.

d) Find the current in the secondary coil, if the current in the primary coil is 4 A.



يتصل الملف الابتدائي لمحول ببطارية 12 V كما هو مبين في الشكل. ما فرق الجهد بين طرفي الملف الثانوي؟

The primary coil in a transformer is connected to a 12 V battery as shown in the figure. What is the potential difference across the secondary coil?

Zero

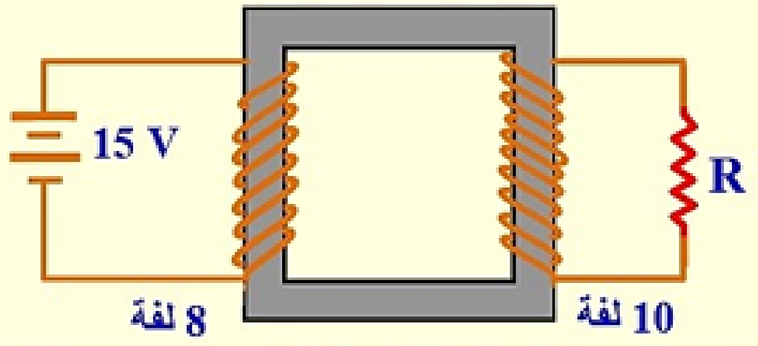
12 V

6.0 V

24 V

1

What is the magnitude of the potential difference across the resistor **R** in the circuit



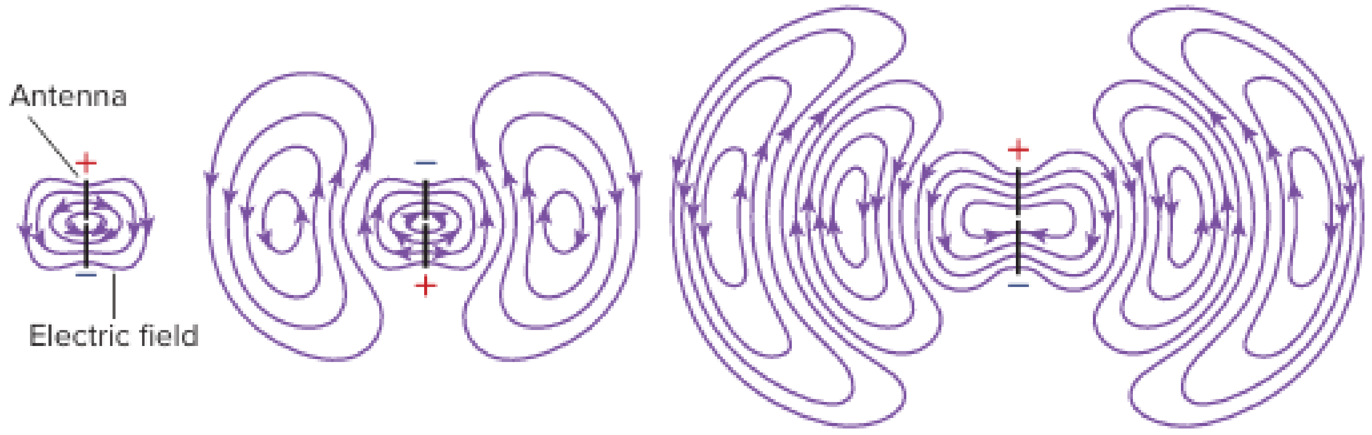
ما مقدار فرق الجهد بين طرفي المقاوم R في الدائرة الكهربائية

A	18.8 V	B	1.2 V	C	15 V	D	0.0 V

7	Explain how the speed of propagation of electromagnetic waves vary through different materials.	student Book	P.176
		Q.(42 - 45)	P.177

PG:176

Propagating Electromagnetic Waves



Propagation through space Radio waves and microwaves are broadcast into space by transmitters connected to antennas. A **transmitter** is a device that converts voice, music, pictures, or data to electronic signals, amplifies the signals, and then sends the signals to an antenna. The **antenna** creates the electromagnetic waves that propagate through the air. How does the antenna do this?

$$v = \frac{c}{\sqrt{k}}$$

In this equation, the wave velocity (v) is measured in meters per second; the speed of light (c) is 3.00×10^8 m/s; and the relative dielectric constant (k) is a dimensionless quantity. In a vacuum, $k = 1.00000$, and the wave velocity is equal to c. In air, $k = 1.00054$, and electromagnetic waves move just slightly slower than c. The dielectric coefficient is the square of the index of refraction, $k = n^2$, so that $\sqrt{k} = n$.

PRACTICE Problems ADDITIONAL PRACTICE

42. What is the speed of an electromagnetic wave traveling through air? Use c = 299,792,458 m/s in your calculation.

43. Water has a dielectric constant of 1.77. What is the speed of light in water?

44. The speed of light traveling through a material is 2.43×10^8 m/s. What is the dielectric constant of the material?

45. CHALLENGE A radio signal is transmitted from Earth's surface to the Moon's surface, 376,290 km away. What is the shortest time a reply can be expected?

يبلغ ثابت العزل الكهربائي للماء (1.77) ما مقدار سرعة الضوء في الماء؟

Water has a dielectric constant of (1.77).What is the speed of light in water?

$2.25 \times 10^8\ m.s^{-1}$

$1.30 \times 10^8\ m.s^{-1}$

$2.99 \times 10^8\ m.s^{-1}$

$3.33 \times 10^8\ m.s^{-1}$

8	Apply the wave equation to calculate the wavelength, frequency, or speed of electromagnetic waves.	Student Book	P.(173 – 175)
		Figure 23; Q.(38 – 41)	P.173; P.174

PG:173

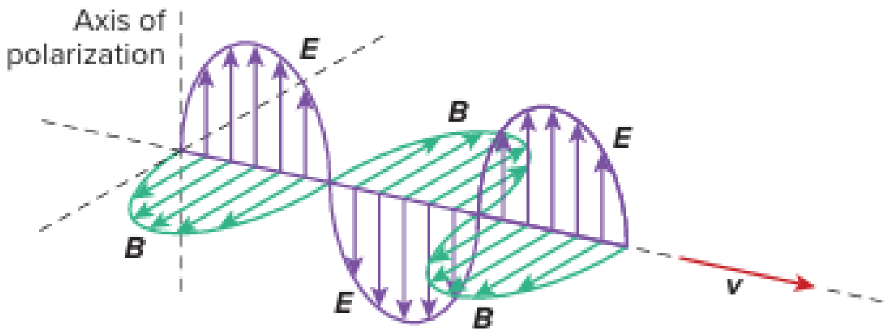


Figure 22 The electric and magnetic fields that make up an electromagnetic wave oscillate at right angles to each other and to the direction of the wave's velocity (v).

Travel in a vacuum All electromagnetic waves move in the same way. Like waves on a rope, electromagnetic waves are transverse waves and can travel through a medium. Unlike other types of waves, electromagnetic waves also can travel in a vacuum. Recall that the speed of a given type of wave depends upon the medium. The speed at which electromagnetic waves travel in a vacuum is 299,792,458 m/s, approximated as 3.00×10^8 m/s and denoted as c, the speed of light. The waves travel only slightly slower in air. Recall that the wavelength, frequency, and speed of a wave are related by the following equation:

$$\lambda = \frac{v}{f}$$

In the equation above, the wavelength (λ) is measured in meters, the speed (v) is measured in meters per second, and the frequency (f) is measured in hertz. For an electromagnetic wave traveling in a vacuum, the speed (v) is equal to the speed of light (c). Thus, for an electromagnetic wave, the equation becomes the following:

$$\lambda = \frac{c}{f}$$

Note that in the wavelength-frequency equation, the product of frequency and wavelength is constant—equal to c—for any electromagnetic wave. Thus, as wavelength increases, frequency decreases, and vice versa.

PRACTICE Problems

ADDITIONAL PRACTICE

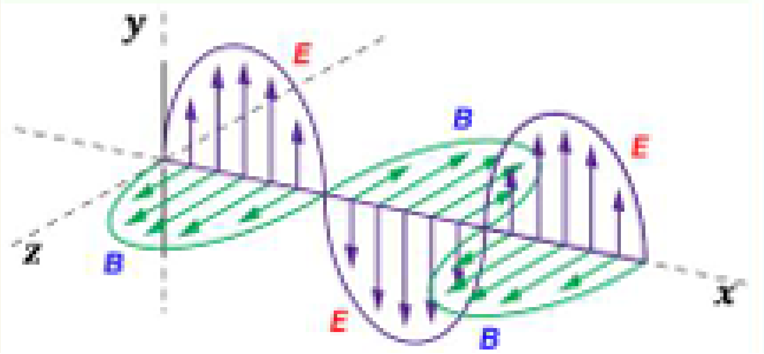
38. What is the wavelength of green light that has a frequency of 5.70×10^{14} Hz?

39. An electromagnetic wave has a frequency of 8.2×10^{14} Hz. What is the wavelength of the wave?

40. What is the frequency of an electromagnetic wave that has a wavelength of 2.2×10^{-2} m?

41. **CHALLENGE** If an electromagnetic wave is propagating to the right and the electric field is in and out of the page, in what direction is the magnetic field?

(2023/2022) (إنسباير) / امتحان نهاية الفصل الثالث/الصف العاشر المتقدم	PHYSICS	Third Term Final Exam/G 10 Adv (Inspire) - (2022/2023)
Part	①	القسم



يوضح الشكل رسماً بيانيا لموجة كهرومغناطيسية حيث يمثل $\vec{E}$ المجال الكهربائي و $\vec{B}$ المجال المغناطيسي.
ما هو اتجاه سرعة الموجة؟

The graph shows an electromagnetic wave where $\vec{E}$ is the electric field and $\vec{B}$ is the magnetic field.
What is the direction of the wave's velocity?

Along the x-axis only.	على طول محور x فقط
Along the y-axis only.	على طول محور y فقط
Along the z-axis only.	على طول محور z فقط
In a direction that is at a nonzero angle to each of the axes.	في اتجاه يصنع زاوية غير صفرية مع كل محور.

8	Apply the wave equation to calculate the wavelength, frequency, or speed of electromagnetic waves.	Student Book	P.(173 – 175)
		Figure 23; Q.(38 – 41)	P.173; P.174

PG:174

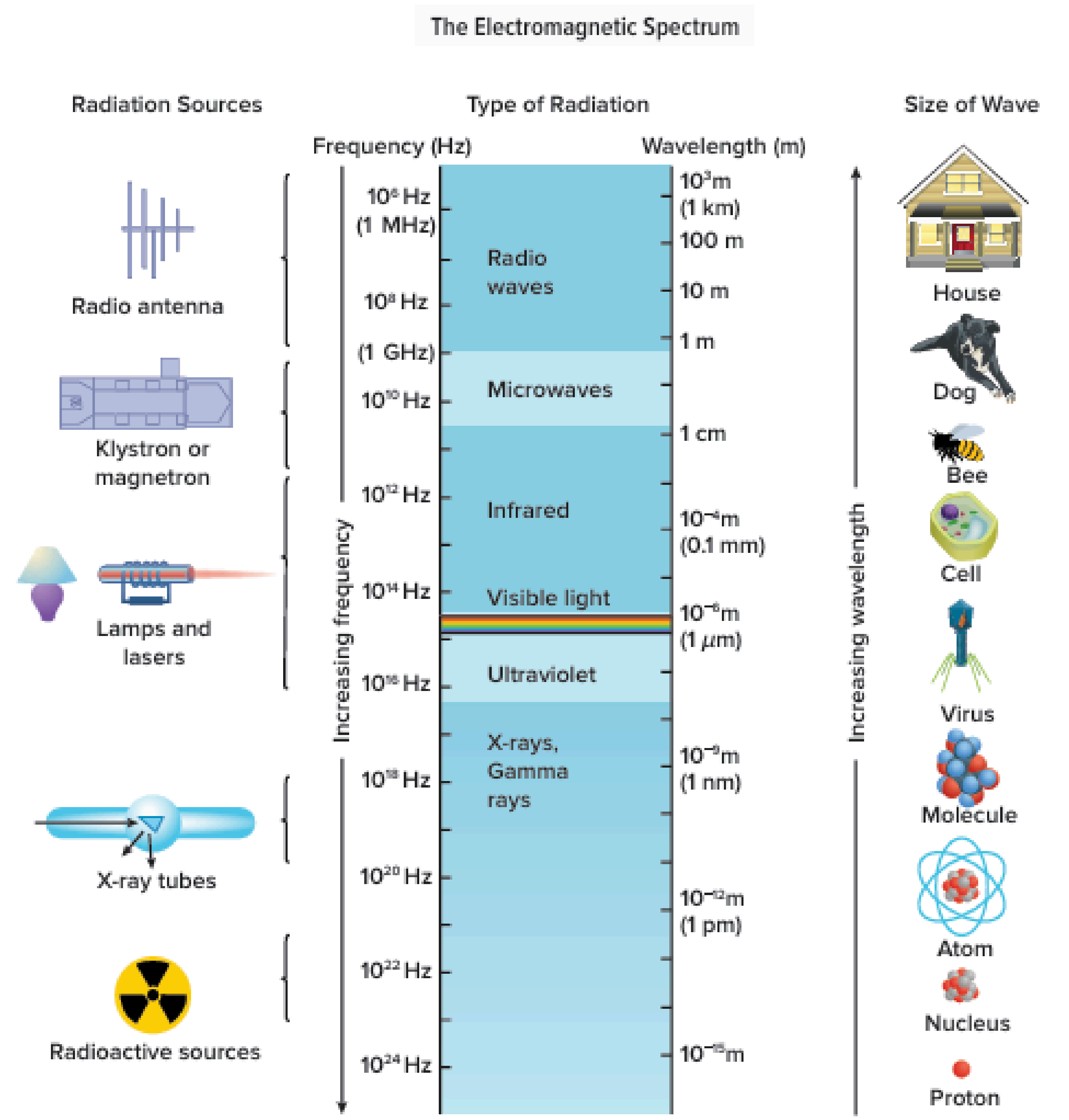


Figure 23 The electromagnetic spectrum contains waves that range from long radio wavelengths larger than houses to short gamma wavelengths smaller than atoms. The left column shows examples of radiation sources. Note that wave frequency extends beyond the frequencies shown in this image.

Observe *Which kind of electromagnetic wave is the size of a proton?*

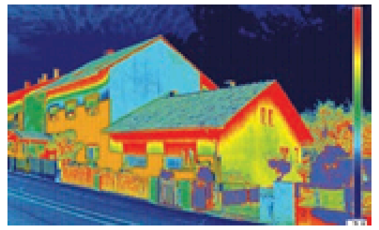
PG:175

Uses of lower-frequency waves

Radio waves The lowest-frequency waves, radio waves, are used mainly to broadcast information. Radio waves with long wavelengths can be transmitted long distances because they reflect off ions in the atmosphere. Shorter radio waves used for FM radio and television travel in straight paths and so must be relayed from station to station across Earth's curved surface.

Microwaves Cellular phones and the Global Positioning System transmit information using very-short-wavelength radio waves called microwaves. You also use microwaves to cook food. The water and fat in food absorb microwaves, and the waves' energy turns to thermal energy to cook the food.

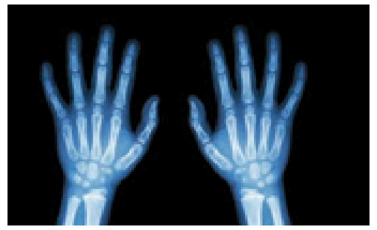
Infrared waves Cameras with infrared sensors can produce images, and infrared night-vision goggles and cameras allow people to see in the dark. Because hot objects emit far infrared waves (with long wavelengths), infrared detectors can measure the temperature of buildings and other objects. Near infrared radiation (with shorter wavelengths and higher frequencies) can carry signals on optical fiber systems or through the air, programmed from remote-control devices.



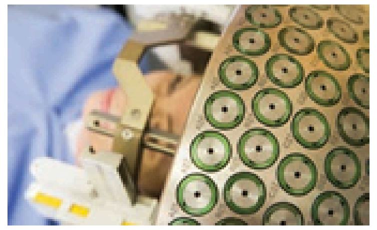
UV radiation With higher frequencies than infrared waves, ultraviolet (UV) radiation can ionize molecules and atoms and cause chemical reactions, resulting in harmful effects such as sunburn. UV radiation also is used in industry to cure polymers and sterilize instruments. In the semiconductor industry, UV radiation is used to etch patterns on silicon wafers in integrated circuits. UV radiation can also be used to reveal forensic evidence.

Uses of higher-frequency waves

X-rays X-rays are produced when high-energy electrons rip tightly bound electrons off atoms. When the electrons in the atoms rearrange themselves, they emit X-rays. German physicist William Roentgen discovered X-rays in 1895 using a vacuum glass tube. You are familiar with X-ray pictures of bones and teeth. X-rays are also widely used to kill cancerous cells.



Gamma rays High-frequency gamma rays come from the radioactive nuclei of atoms. Gamma rays can be used to detect dangerous substances in shipping containers. In medicine, they are used to treat cancer by destroying cells.



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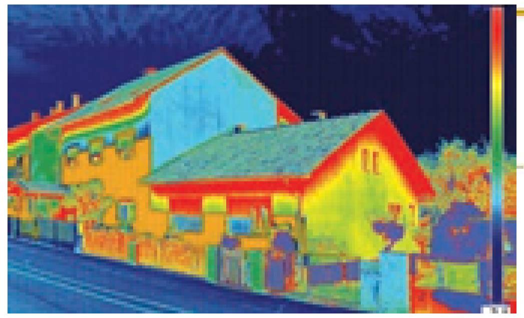
8	Apply the wave equation to calculate the wavelength, frequency, or speed of electromagnetic waves.	Student Book	P.(173 – 175)
		Figure 23; Q.(38 – 41)	P.173; P.174

أي من انواع الطيف الكهرومغناطيسي يستخدم في الصورة المجاورة؟

Which type of the electromagnetic spectrum is used in the picture?

X-Rays	أشعه اكس
Infrared waves	أشعة تحت حمراء
Gamma rays	أشعة جاما
Ultraviolet	فوق بنفسجية



أي من انواع الطيف الكهرومغناطيسي يستخدم في الصورة المجاورة؟

Which type of the electromagnetic spectrum is used in the picture?

X-Rays	أشعه اكس
Infrared waves	أشعة تحت حمراء
Gamma rays	أشعة جاما
Ultraviolet	فوق بنفسجية

موقع المناهج الإماراتية
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9	Determine the optimal length or orientation of an antenna for the best reception of a given wave.	Student Book	P.(179 – 180)
		Q.(49, 51)	P.181

Frequencies set by piezoelectricity There are other ways of generating oscillating potential differences for transmitters. For example, quartz crystals deform when a potential difference is applied across them, a property known as **piezoelectricity.** The application of an AC potential difference to a cut section of quartz crystal results in sustained oscillations. Just as a piece of metal vibrates at a specific frequency when it is bent and released, so does a quartz crystal. The thinner the crystal, the higher is the vibration frequency.

A crystal's piezoelectric property also generates an EMF when the crystal is deformed. This EMF is produced at the vibrating frequency of the crystal, so it can be amplified and returned to the crystal to keep it vibrating. Because of their nearly constant vibration frequencies, quartz crystals are commonly used to generate electromagnetic waves in cell phones, television, wireless phones, wireless WiFi routers, and computers.

Receiving Electromagnetic Waves

Antennas propagate electromagnetic waves into space. Antennas also capture electromagnetic waves, converting the waves' oscillating electric fields back to potential differences. As shown in **Figure 29**, a wave's electric field accelerates electrons in the metal of an antenna. The acceleration is largest when the antenna is positioned in the same direction as the wave polarization; that is, when it is parallel to the direction of the wave's electric field. A potential difference across the antenna's terminals oscillates at the frequency of the wave.

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Get It?
Infer why the direction in which an antenna points affects its function.

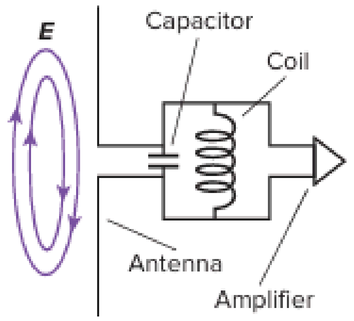


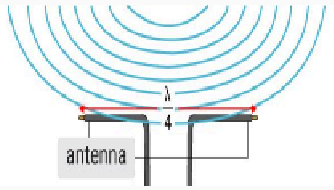
Figure 29 The changing electric fields from a r
electron
The info
then be
to drive

dish antennas

The dish antenna is able only to receive signals coming from specific directions.

a parabolic shape made up of metal or dielectric materials used to receive or transmit radio and TV signals

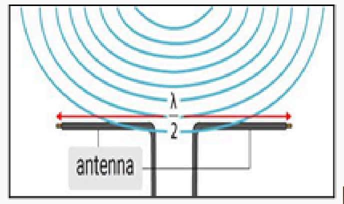
$\frac{\lambda}{4} =$ طول الهوائي



the connection between the antenna and the receiver is at the end of the antenna

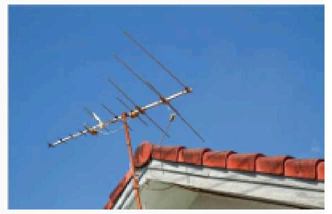
are less efficient

$\frac{\lambda}{2} =$ طول الهوائي



are most efficient

Wire antennas



the wave's electric field vibrates the electrons in the antenna's metal. This vibration creates a potential difference inside the antenna and sends it to a receiver

A receiver is a device that receives potential differences from the antenna and converts them into usable information.

Wire antennas When an antenna is one-half the length of the wave it is designed to detect, the potential difference across its terminals is largest and the antenna is most efficient. Therefore, an antenna designed to receive radio waves is longer than one designed to receive microwaves.

Though antennas that are one-half wavelength long are most efficient, antennas that are one-quarter wavelength long are often used when the connection between the antenna and receiver is at the end rather than the middle of the antenna. Antennas can be made shorter by constructing them from a helical coil or by adding a dielectric material, such as a ceramic, with a dielectric coefficient higher than air.

Cell phones have as many as seven antennas. These phones typically communicate at frequencies near 850, 1700, 1900, and 2100 MHz. Further, they receive GPS signals at 1.575 GHz. They send and receive remote earpiece and WiFi signals at 2.4 GHz. Cell phone antennas built on ceramic dielectric blocks using printed conductors are typically only a few millimeters long. Laptop computers also have several antennas to accommodate WiFi and remote devices.

Dish antennas All electromagnetic waves, not just light waves, undergo reflection, refraction, and diffraction. Dish antennas, such as the one in **Figure 30**, reflect short-wavelength radio signals, just as parabolic mirrors reflect light waves. A parabolic dish antenna reflects and focuses signals off its surface and into a horn. The horn, supported by a tripod structure over the main dish, contains a short dipole antenna. Like a telescope that shows only a narrow portion of sky, a dish antenna is sensitive only to signals coming from specific directions.

Converting waves to information After an antenna converts the electric fields of electromagnetic waves to potential differences, it sends the potential differences to a **receiver,** which converts them to usable information—sound, pictures, or data. Waves of different frequencies strike an antenna and enter the receiver simultaneously. To select waves of a particular frequency only, a receiver uses a tuner. A tuner has a coil-and-capacitor circuit or a resonant cavity. When you turn a radio dial, you select a radio station by adjusting the capacitance until the oscillation frequency of the circuit equals the frequency of the desired wave. Then, only waves of the desired frequency can produce oscillating potential differences of significant amplitude in the receiver.

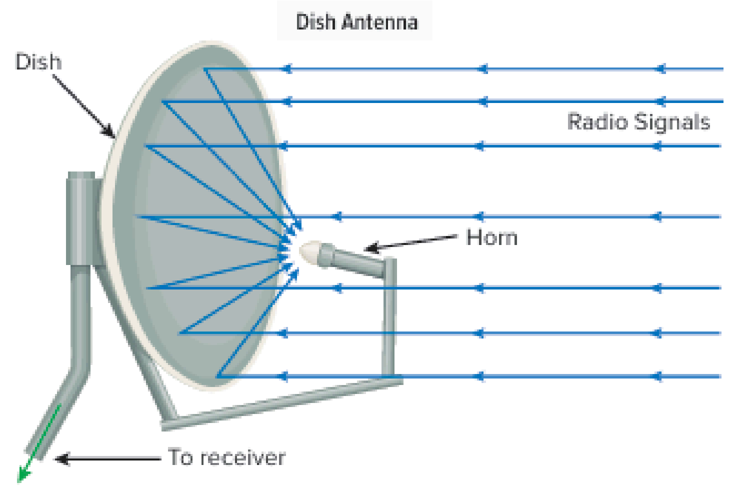


Figure 30 A received signal is reflected off the surface of a dish and focused into the horn, which contains the antenna. The large surface area of the dish collects more electromagnetic wave energy than a wire antenna does, making it well suited for receiving weak radio signals.

FM and AM signals Recall that an electromagnetic wave can carry information only if some property of the wave is changed, or modulated, by the information. A radio station's carrier wave is varied either in amplitude (AM, or Amplitude Modulation) or in frequency (FM, or Frequency Modulation). Commercial AM stations broadcast in the 530–1700 kHz band, while commercial FM stations broadcast between 88 and 108 MHz. FM signals have less noise because most noise sources, such as lightning, create waves of varying amplitude to which FM receivers are insensitive. Many radio services, including commercial, emergency, and two-way walkie talkies, use other frequencies and either FM or AM modulation.

Digital signals Information can be digitized. For example, a picture can be stored as the values of an array of pixels. In this form, it can be stored reliably in computer memory and sent over long distances. Cell phones, televisions, and computers convert digital signals to sound, pictures, and data. Digital signals can be sent and received as a series of wave pulses that are usually encoded and interpreted using a binary system of 1s and 0s that vary in duration, not amplitude or frequency. Digital signals can send more information in the same amount of time as AM or FM and are less affected by noise.

Real-World Physics

DIGITAL TV On June 12, 2009, all full-power U.S. television stations ceased broadcasting analog signals. Analog TV signals, like FM and AM radio signals, are broadcast by modulating carrier waves. Television stations now broadcast only digital signals, which are encoded into 0s and 1s—the digital code used in computers. Digital TV bandwidth can be compressed to provide four, five, or more channels in the same carrier frequency used by a single channel in analog TV. Digital TV also has higher-fidelity sound and carries about five times more picture information.

Q1

Radio stations use two ways to modulate the carrier waves: amplitude modulation (AM) and frequency modulation (FM). Which of the following is correct?

1 frequency modulation means modifying the frequency and the amplitude of the transmitted carrier wave

2 frequency modulation is used to modify the frequency of the transmitted carrier wave while the amplitude remains constant

Q2

Which of the following is the correct definition of digital signals?

1 a series of pulses of 1 s and 0 s encoded into a binary system

2 materials that are poor conductors of electric current whose electric charges partially align with an electric field

Q3

Radio stations use two ways to modulate the carrier waves: amplitude modulation (AM) and frequency modulation (FM). Which of the following is correct?

1 both FM and AM are affected the same by noise

2 FM signals are less affected by noise than AM signals

Select the correct answer.

Dish antennas consist of two main components. Select them.

- [ ] amplifier
- [x] horn converter
- [ ] transmitter
- [ ] circular rubber
- [x] reflector

Q14 Which of the following is the correct definition of a receiver?		أي مما يلي هو التعريف الصحيح للمستقبل؟	
A	a device that shows the range of different wavelengths and frequencies over which electromagnetic waves extend	C	a device that creates electromagnetic waves that propagate through the air and vacuum
B	a device that gets potential differences from the antenna and converts them into usable information	D	is an electronic device used to convert data like voice to electronic signals

10 Recall the concepts of constructive and destructive interference and define interference fringes of light.

Student Book	P.191
Figure 6	P.191

Constructive التداخل البناء Interference	Destructive التداخل الهدام Interference
$\frac{m\lambda}{d} = \frac{x}{L}$	$\frac{(m - \frac{1}{2})\lambda}{d} = \frac{x}{L}$

- Depending on their phase relationship, the two waves undergo constructive or destructive interference.
- When the light from the slits is projected on a screen, the constructive and destructive interference results in a pattern of light and dark bands called interference fringes.

Coherent Light

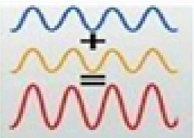
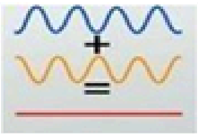
light made up of waves of the same wavelength that are in phase with each other.

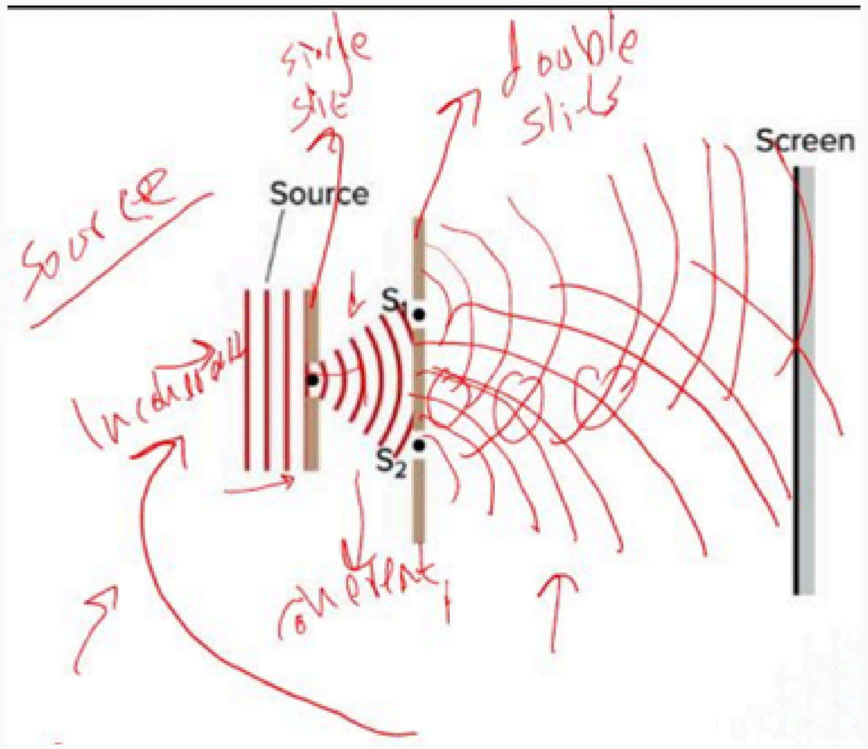
Example: laser

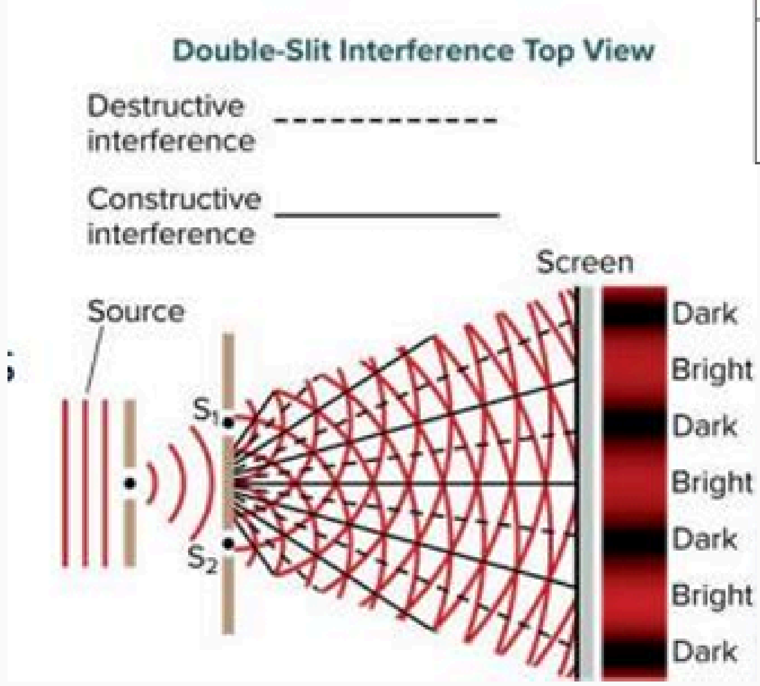
Incoherent Light

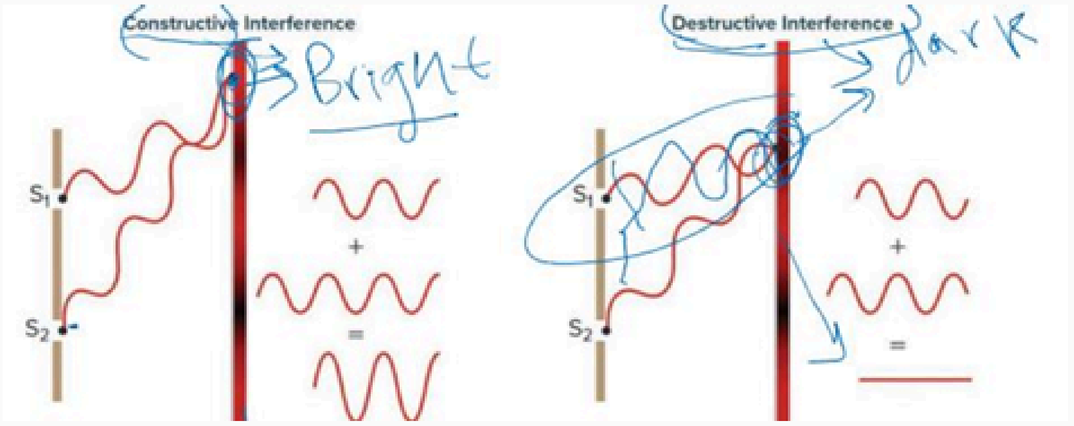
Incoherent light is light whose waves are not in phase, such as white light from a light bulb.

Example: light bulb

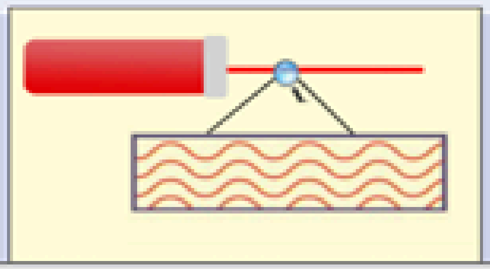
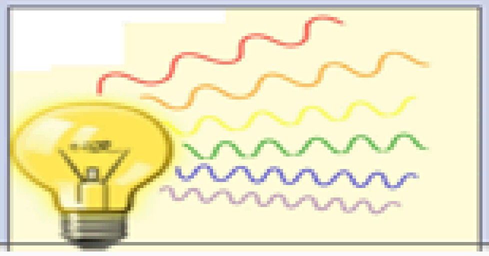
Constructive	Destructive
When two waves meet in such a way that their crests line up together.	When two waves meet in such a way that the crest of one wave meets the trough of another.
	

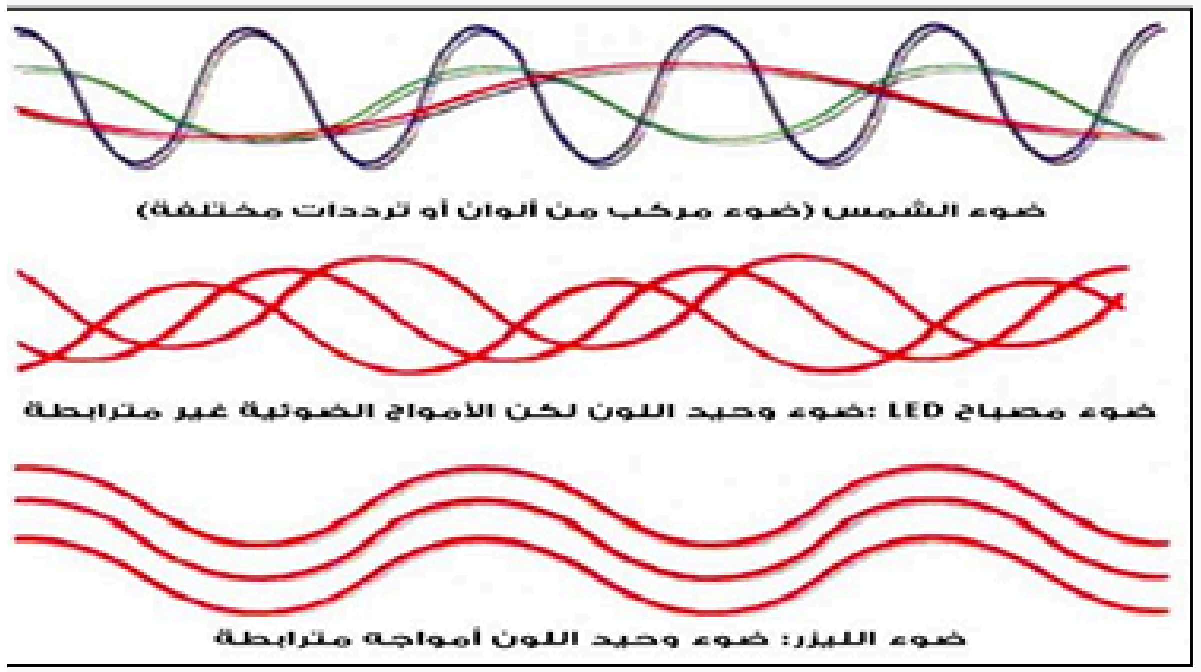






10	Recall the concepts of constructive and destructive interference and define interference fringes of light.	Student Book	P.191
		Figure 6	P.191

الضوء المترابط coherent light	الضوء غير المترابط Incoherent light
الضوء الذي تكون موجاته لها نفس الطول الموج (اللون) وتكون متفقة في الطور Light whose waves have the same wavelength (colour) and are in phase	الضوء الذي تختلف موجاته في الطور Light whose waves differ in phase
ضوء الليزر Laser light	الضوء الأبيض الصادر من مصباح قريب White light from a nearby lamp
	



في تجربة التداخل:

In the interference experiment

- يكون المصدرين مترابطين
  The two sources are coherent

- يكون الضوء أحادي اللون
  The light is monochromatic

10	Recall the concepts of constructive and destructive interference and define interference fringes of light.	Student Book	P.191
		Figure 6	P.191

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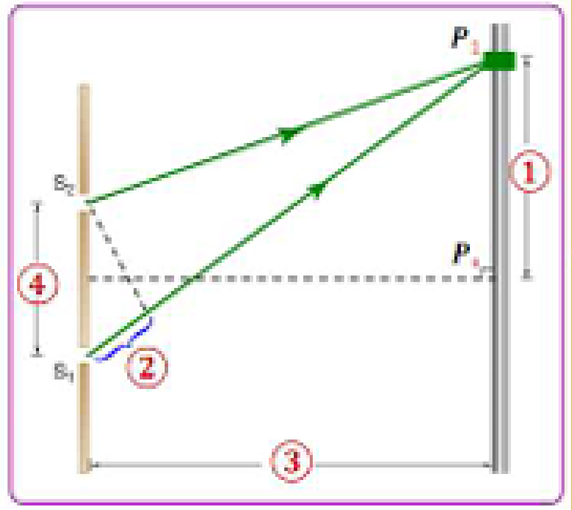
Part	②	القسم



أي من الارقام على الشكل يشير إلى الطول الموجي للضوء المستخدم في تجربة الشق المزدوج؟

Which number on the figure indicates the wavelength of the light used in the double-slit experiment?

②

③

①

④

11	Explain how bright and dark interference fringes (bands) are created in a double-slit interference investigation with monochromatic light.	Student Book	P.195
		Content	P.195

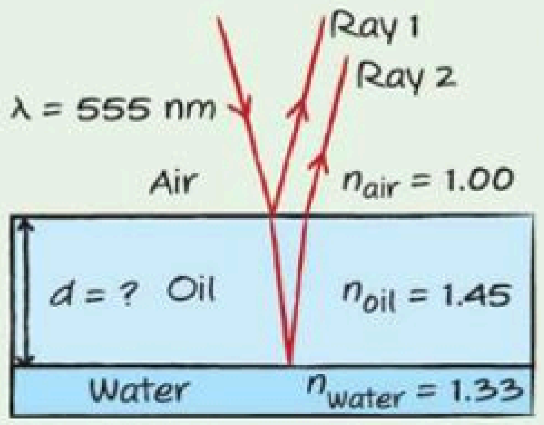
EXAMPLE Problem 2

OIL AND WATER

You observe colored rings on a puddle and conclude that there must be an oil slick on the water. You look directly down at the puddle and see a yellow-green (λ = 555 nm) region. If the index of refraction of oil is 1.45 and that of water is 1.33, what is the minimum thickness of oil that could cause this color?

1. ANALYZE AND SKETCH THE PROBLEM

- Sketch the thin film and layers above and below it.
- Draw rays showing reflection off the top of the film as well as the bottom.



Equations for Thin-Film Interference Problems

Number of Inverted Waves	Constructive Interference	Destructive Interference
0	$2dn = m\lambda_{film}$	$2dn = (m + ½)\,\lambda_{film}$
1	$2dn = (m + ½)\,\lambda_{film}$	$2dn = m\lambda_{film}$
2	$2dn = m\lambda_{film}$	$2dn = (m + ½)\,\lambda_{film}$

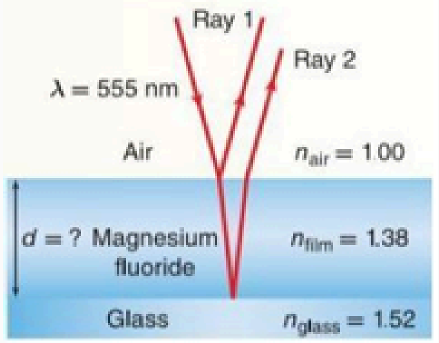
Note: m = 1, 2, 3, etc. In the case of $(m + ½)\lambda_{film}$, m can also be 0.

When solving thin-film interference problems, use the following strategies:

1. Make a sketch of the thin film and the two coherent waves.
2. Determine whether the interference is constructive or destructive.
3. Determine if either or both waves inverted on reflection. If the index of refraction changes from a lower to a higher value, then the wave is inverted.
4. Find the thickness of the film needed to create the interference using the appropriate equation from the table.

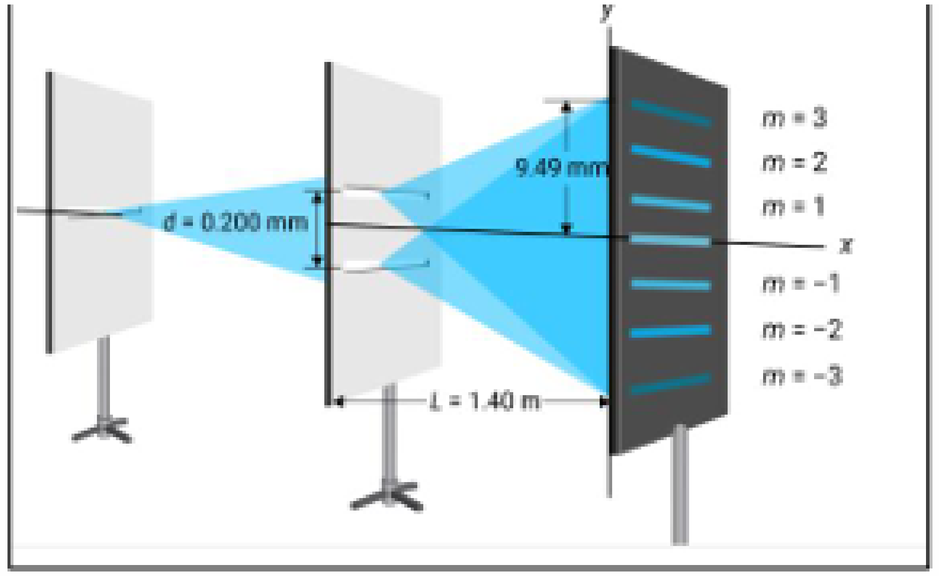
Practice problems 5-9 (p199)

A glass lens has a nonreflective coating of magnesium fluoride placed on it. How thick should the nonreflective layer be to keep yellow-green light with a wavelength of 555 nm from being reflected? See the sketch in the figure.



Q15 In the double slit experiment. The physics students used laser beams with a wavelength of λ= 632.8 nm, and one of the students placed the screen 1 m away. From both sides. He found the distance between the first-order luminous beam and the central beam to be 65.5 mm. What is the distance between the two slits?		في تجربة الشق المزدوج. استخدم طلاب الفيزياء أشعة ليزر طولها الموجي 632.8 nm =λ ووضع أحد الطلاب الشاشة على بعد 1m من الشقين. فوجد المسافة بين الحزمة المضيئة ذات الرتبة الأولى والحزمة المركزية هي 65.5mm. ما المسافة بين الشقين؟	
A	$6.66\times10^{-6}\ m$	C	$6.66\times10^{-3}\ m$
B	$9.66\times10^{-3}\ m$	$\boxed{\text{D}}$	$9.66\times10^{-6}\ m$

Q16 calculate the wavelength .



$$\frac{m\lambda}{d}=\frac{x}{L}$$

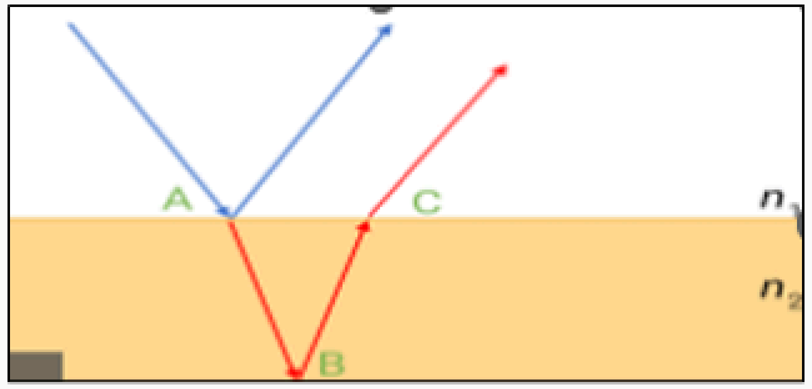
$$\frac{3\lambda}{0.200\times10^{-3}}=\frac{9.49\times10^{-3}}{1.40}$$

$$\lambda=4.5\times10^{-7}m$$

12	Discuss the phenomenon of thin-film interference as one example of light interference in nature, and explain how the refractive indexes of the mediums that make the thin film control wave inversion.	Student Book	P.(193 – 194)
		Figure 8; Q.(5 – 9)	P.193; P.195

A thin-film interference is a phenomenon where light waves are reflecting off the top and the bottom surfaces of a thin film

Examples: - a soap bubble - a thin layer of oil on the surface of the water - the wings of a blue morpho butterfly

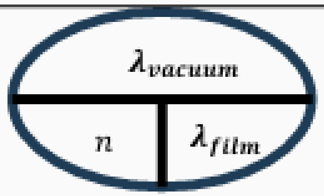


Consider a film of thickness *d*. The blue ray refracts and reflects when it touches point A. The red ray reflects at point B to reach point C and refracts.

The blue ray and the red ray are assumed to be parallel to each other when they leave the film.

Constructive Interference	Destructive Interference
$2d = \left(m + \frac{1}{2}\right)\lambda_{film}$	$2d = (m+1)\ \lambda_{film}$

الطول الموجي للضوء	λ
سمك الغشاء الرقيق	d
رقم الهدبة المضيئة أو المظلمة	m
معامل انكسار الوسط للضوء	n



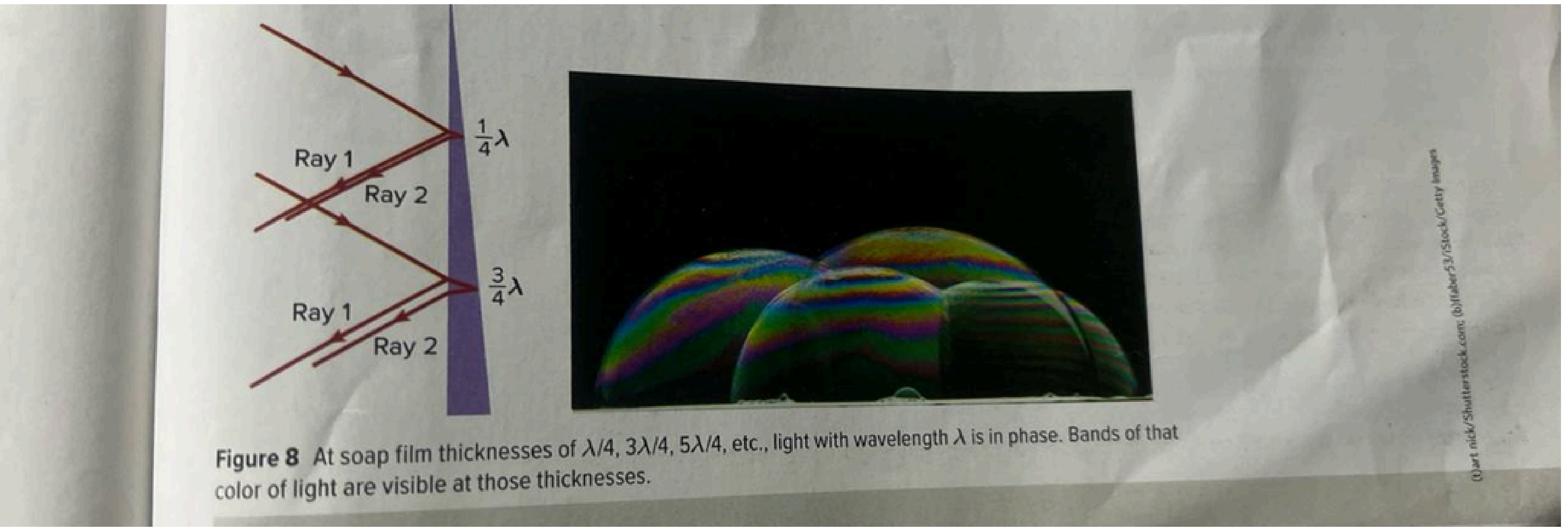
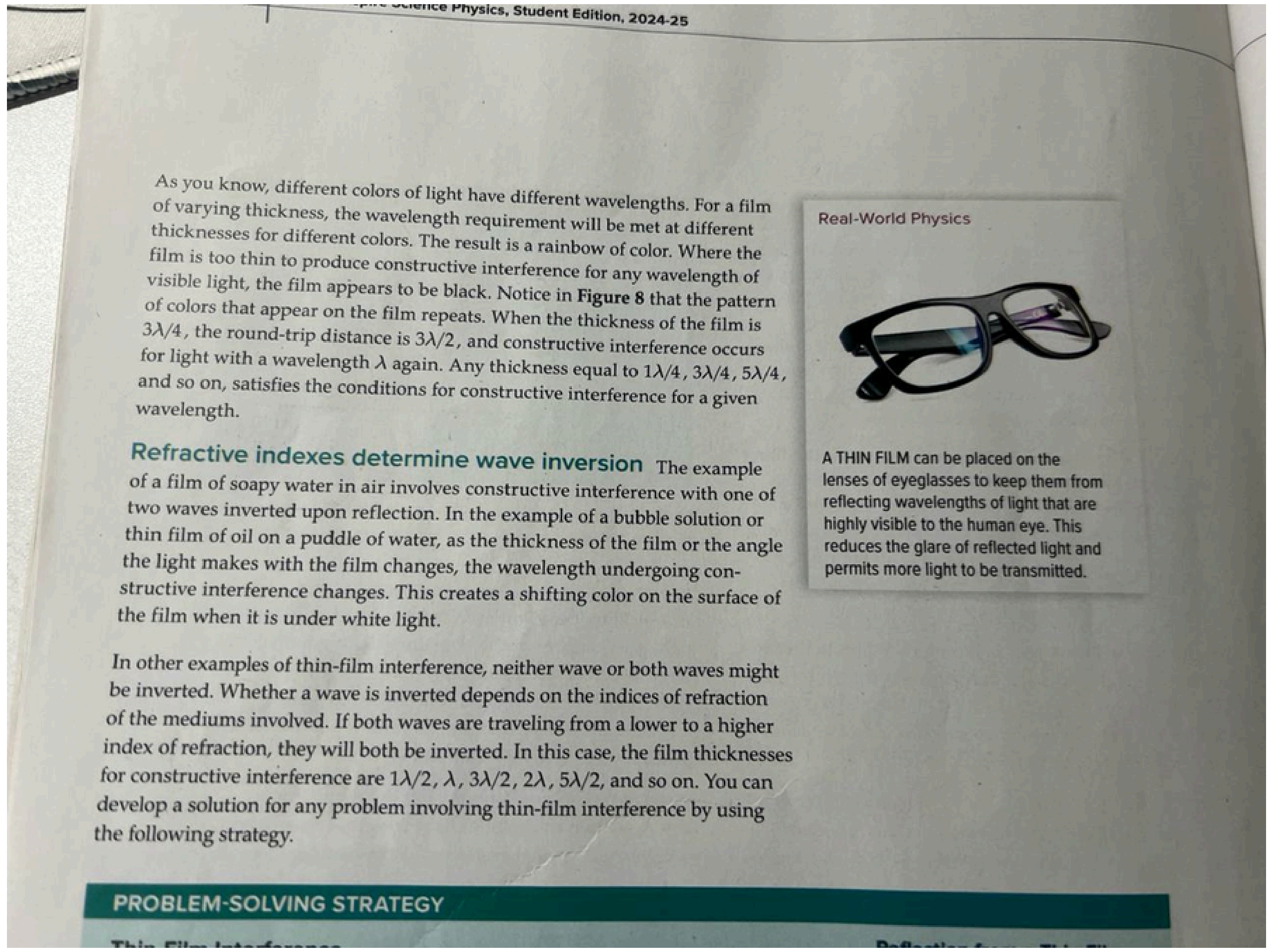


Figure 8 At soap film thicknesses of $\lambda/4$, $3\lambda/4$, $5\lambda/4$, etc., light with wavelength λ is in phase. Bands of that color of light are visible at those thicknesses.



As you know, different colors of light have different wavelengths. For a film of varying thickness, the wavelength requirement will be met at different thicknesses for different colors. The result is a rainbow of color. Where the film is too thin to produce constructive interference for any wavelength of visible light, the film appears to be black. Notice in **Figure 8** that the pattern of colors that appear on the film repeats. When the thickness of the film is $3\lambda/4$, the round-trip distance is $3\lambda/2$, and constructive interference occurs for light with a wavelength λ again. Any thickness equal to $1\lambda/4$, $3\lambda/4$, $5\lambda/4$, and so on, satisfies the conditions for constructive interference for a given wavelength.

Refractive indexes determine wave inversion The example of a film of soapy water in air involves constructive interference with one of two waves inverted upon reflection. In the example of a bubble solution or thin film of oil on a puddle of water, as the thickness of the film or the angle the light makes with the film changes, the wavelength undergoing constructive interference changes. This creates a shifting color on the surface of the film when it is under white light.

In other examples of thin-film interference, neither wave or both waves might be inverted. Whether a wave is inverted depends on the indices of refraction of the mediums involved. If both waves are traveling from a lower to a higher index of refraction, they will both be inverted. In this case, the film thicknesses for constructive interference are $1\lambda/2$, λ, $3\lambda/2$, 2λ, $5\lambda/2$, and so on. You can develop a solution for any problem involving thin-film interference by using the following strategy.

Real-World Physics

A THIN FILM can be placed on the lenses of eyeglasses to keep them from reflecting wavelengths of light that are highly visible to the human eye. This reduces the glare of reflected light and permits more light to be transmitted.

PROBLEM-SOLVING STRATEGY

12	Discuss the phenomenon of thin-film interference as one example of light interference in nature, and explain how the refractive indexes of the mediums that make the thin film control wave inversion.	Student Book	P.(193 – 194)
		Figure 8; Q.(5 – 9)	P.193; P.195

PRACTICE Problems

ADDITIONAL PRACTICE

5. In the situation in Example Problem 2, what would be the thinnest film that would create a reflected red ($\lambda = 635$ nm) band?
6. A glass lens has a nonreflective coating of magnesium fluoride placed on it. How thick should the nonreflective layer be to keep yellow-green light with a wavelength of 555 nm from being reflected? See **Figure 9**.
7. You can observe thin-film interference by dipping a bubble wand into some bubble solution and holding the wand in the air. What is the thickness of the thinnest soap film at which you would see a black stripe if the light illuminating the film has a wavelength of 521 nm? Use $n = 1.33$ for the bubble solution.
8. What is the thinnest soap film ($n = 1.33$) for which light of wavelength 521 nm will constructively interfere with itself?
9. **CHALLENGE** A silicon solar cell has a nonreflective coating placed on it. If a film of silicon monoxide, $n = 1.45$, is placed on the silicon, $n = 3.5$, how thick should the layer be to keep yellow-green light ($\lambda = 555$ nm) from being reflected?

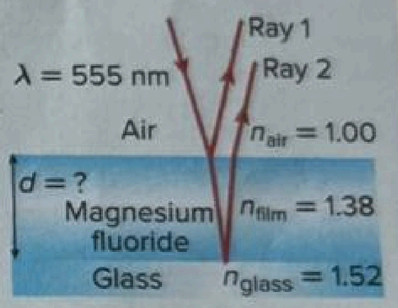
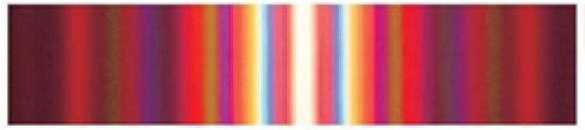


Figure 9

13	1. Explain the formation of a colored spectra when white light is used in a double-slit investigation. 2. Explain how coherent light is generated by passing monochromatic light through slits .	Student Book	P.189
		Figure 3	P.189

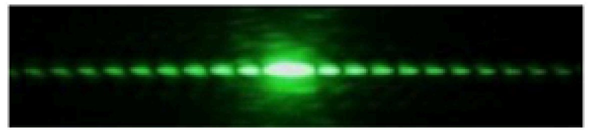
Describe the pattern that Thomas Young gets in his experiment (Double-Slit Interference) when he uses a white light.



✓ A bright central band of white color on the screen.
✓ Colored spectra on either side of the central band.

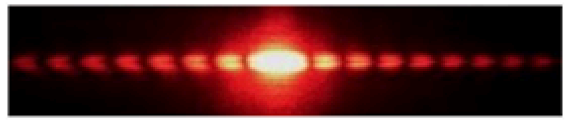
The pattern that is produced when light passes through a slit that has two closely spaced edges, as results from constructive and destructive interference of Huygens' wavelets

2- The following figure shows the diffraction pattern of green light, describe this pattern.



- Wide, bright central band.
- Narrower bright bands on either side of the central bright band.
- Dark bands between the bright bands.
- Dim regions between bright and dark bands

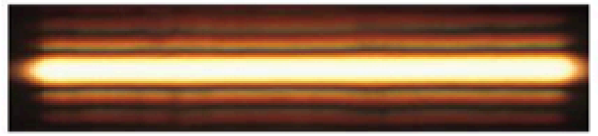
3- How does this pattern change when a red light is used instead of the green light?



The width of central bright band and the other bands will increase because the wavelength of red light is longer than the green light

4- How does this pattern change when a white light is used?

The pattern will be a combination of patterns of all the colors of the spectrum.



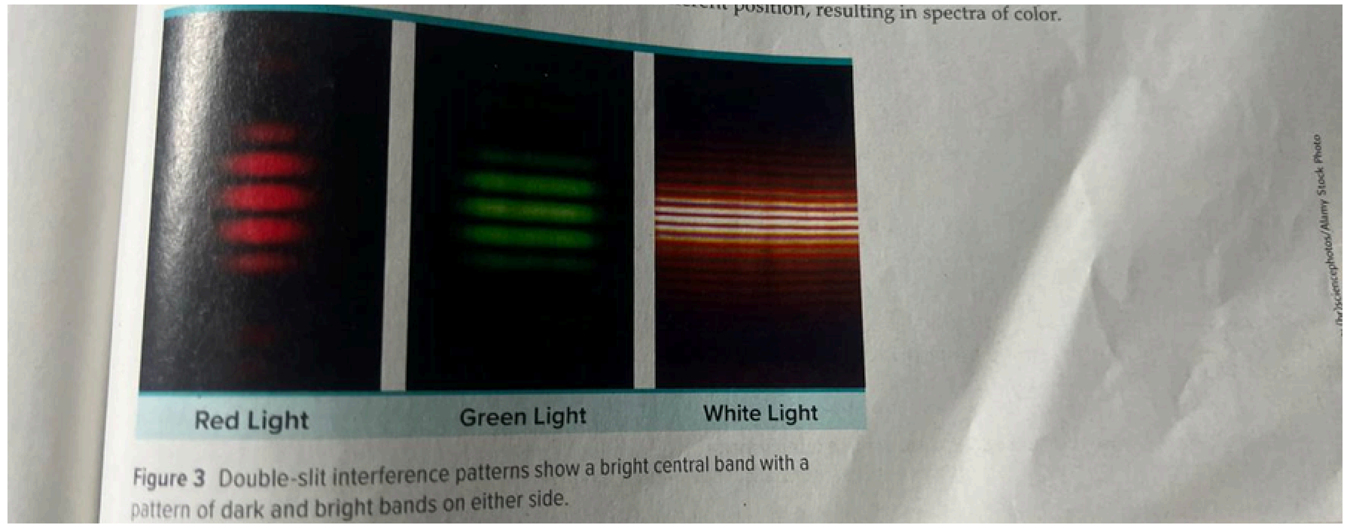


Figure 3 Double-slit interference patterns show a bright central band with a pattern of dark and bright bands on either side.

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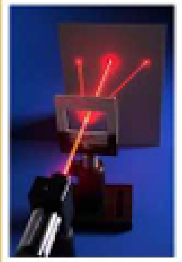
Part	②	القسم



ما هي الأداة المكونة من شقوق كثيرة صغيرة والتي تسبّب حيود الضوء وتكوّن نمطا يشبه نمط التداخل الناتج عن شق مزدوج؟

A device that is made up of many small slits that diffract light and forms a pattern that is similar to that of two-slit interference pattern?

موقع المناهج الإماراتية

A diffraction grating	محزوز الحيود

A transmitter	جهاز الارسال

A thin-film interference	تداخل الاغشية الرقيقة

Thomas Young principle	مبدأ توماس يتغ

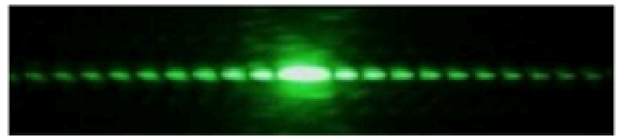
14	Explain the diffraction of light according to Huygen's principle (all the points of a wavefront of light can be thought of as new sources of smaller waves called wavelets), to form a diffraction pattern.	Student Book	P.(197 - 199)
		PHYSICS Challenge Q.(1 - 2)	P.199;

15	Define diffraction as the bending of a wave as it passes the edge of a barrier, and how the diffraction pattern that is created when light (green, red, white..) passes through a single slit, with Illustration by Huygen's wavelets the diffraction patterns.	Student Book	P.(197 – 199)
		Text Book	P.(197 – 199)

1- Define the diffraction pattern

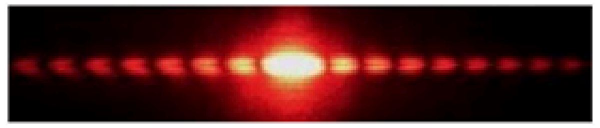
The pattern that is produced when light passes through a slit that has two closely spaced edges, as results from constructive and destructive interference of Huygens' wavelets

2- The following figure shows the diffraction pattern of green light, describe this pattern.



- Wide, bright central band.
- Narrower bright bands on either side of the central bright band.
- Dark bands between the bright bands.
- Dim regions between bright and dark bands

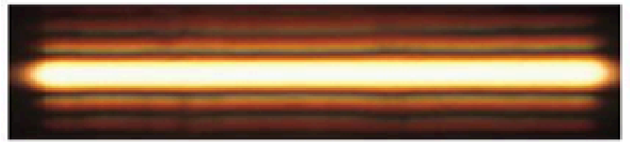
3- How does this pattern change when a red light is used instead of the green light?



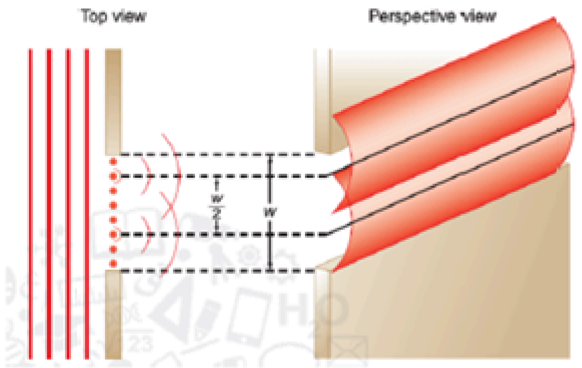
The width of central bright band and the other bands will increase because the wavelength of red light is longer than the green light

4- How does this pattern change when a white light is used?

The pattern will be a combination of patterns of all the colors of the spectrum.



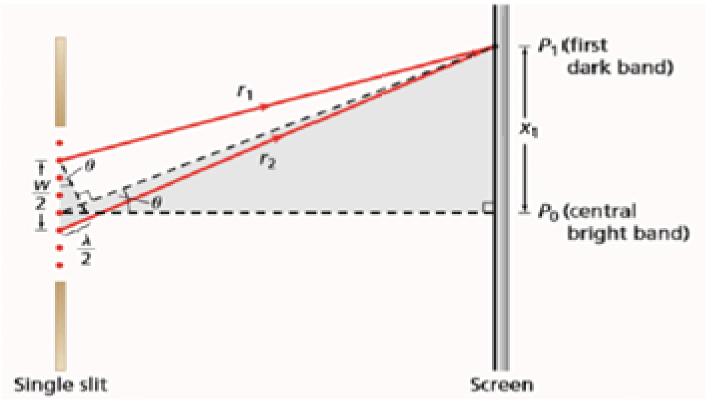
6- Under which conditions we can conclude an equation to find the distance between the dark band and the central bright band?



- The distance to the screen is much larger than w.
- The separation distance between the sources of the two interfering waves is w/2
- Note: A better method of determining the distance of the first dark band is to measure the width of the central bright band

7- Write an equation to measure the width of the central bright band.

$$\boxed{2x_1 = \frac{2\lambda L}{w}}$$

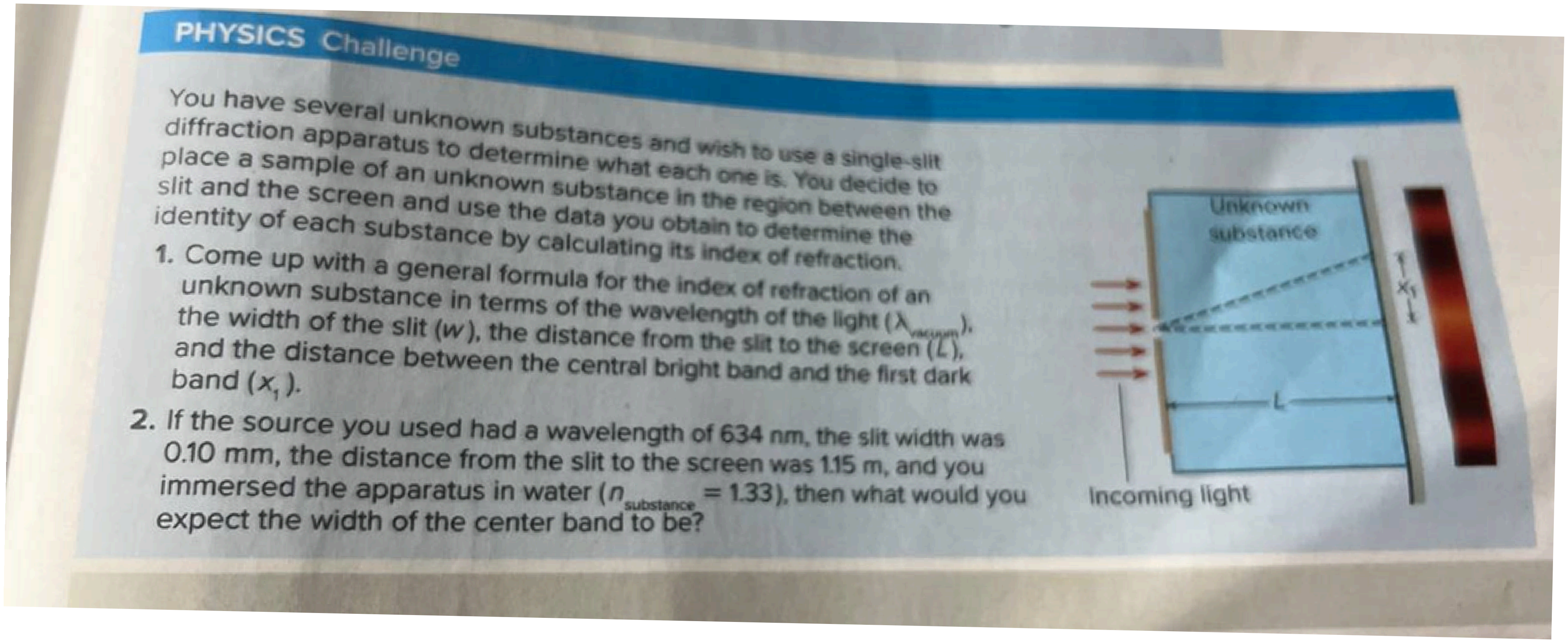


N	The symbol	The physical quantity
1	x_1	The distance between the first dark band and the central band
2	$2x_1$	The width of the central bright band
3	λ	The wavelength of the used light
4	w	The width of the single slit
5	L	The distance to the screen

Important note: Single-slit diffraction patterns make the wave nature of light noticeable when the slits are 10 to 100 times the wavelength of the light. Larger openings, however, cast sharp shadows, as Isaac Newton first observed.

While the single-slit pattern depends on the wavelength of light, it is only when a large number of slits are put together that diffraction provides a useful tool for measuring wavelength

14	Explain the diffraction of light according to Huygen's principle (all the points of a wavefront of light can be thought of as new sources of smaller waves called wavelets), to form a diffraction pattern.	Student Book PHYSICS Challenge Q.(1 - 2)	P.(197 - 199) P.199;



PHYSICS Challenge

You have several unknown substances and wish to use a single-slit diffraction apparatus to determine what each one is. You decide to place a sample of an unknown substance in the region between the slit and the screen and use the data you obtain to determine the identity of each substance by calculating its index of refraction.

1. Come up with a general formula for the index of refraction of an unknown substance in terms of the wavelength of the light (λ_{vacuum}), the width of the slit (w), the distance from the slit to the screen (L), and the distance between the central bright band and the first dark band (x_1).

2. If the source you used had a wavelength of 634 nm, the slit width was 0.10 mm, the distance from the slit to the screen was 1.15 m, and you immersed the apparatus in water ($n_{substance}$ = 1.33), then what would you expect the width of the center band to be?

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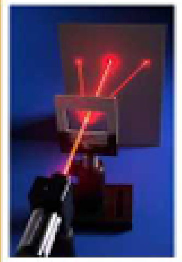

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Thomas Young principle	مبدأ توماس يونغ

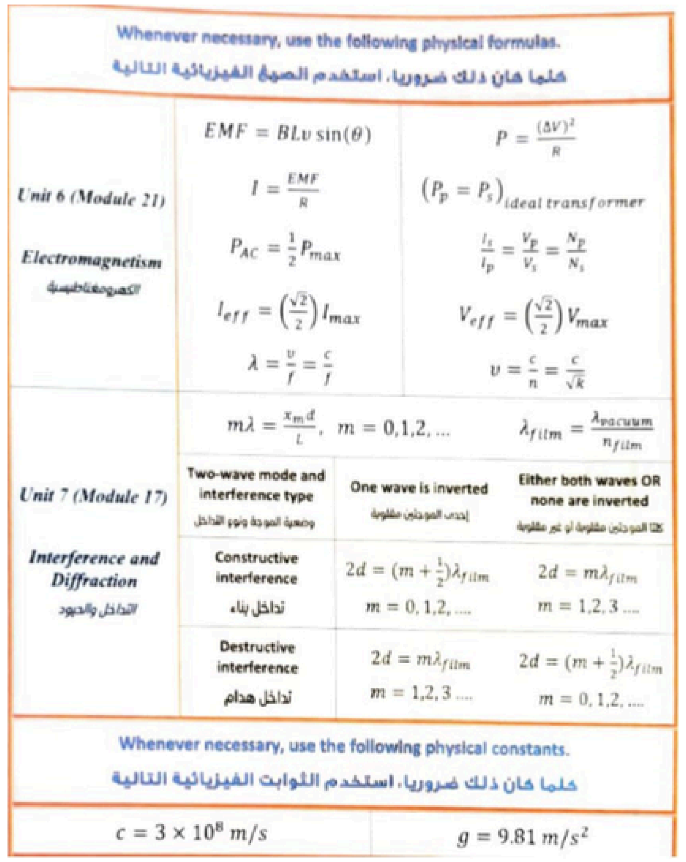
الجزء الكتابي
FQR

https://t.me/Advvv10

$EMF = BLv\,sin\theta$	*effective current* $I_{eff} = \left(\frac{\sqrt{2}}{2}\right) I_{max}$	*effective potential* $V_{eff} = \left(\frac{\sqrt{2}}{2}\right) V_{max}$
average power $P_{AC} = \frac{1}{2} P_{AC\,max}$	Power P = IV	$\frac{I_s}{I_p} = \frac{V_p}{V_s} = \frac{N_p}{N_s}$

$I = \frac{EMF}{R}$	Turns ratio $= \frac{N_s}{N_p}$	$P_P = I_P V_P$ $P_S = I_S V_S$
$c = \lambda f$	$v = \lambda f$	$v = \frac{c}{\sqrt{k}}$
Speed of light in vacuum $3 \times 10^8\ m/s$	$c = 10^{-2}$ $m = 10^{-3}$ $\mu = 10^{-6}$ $n = 10^{-9}$	

Thin film $2d = \left(m + \frac{1}{2}\right)\left(\frac{\lambda}{n_{film}}\right)$		$2d = m\lambda_{film}$	$\lambda_{film} = \frac{\lambda_{vacuum}}{n_{film}}$
Single slit $2x_1 = \frac{2\lambda L}{w}$	Double slit $\lambda = \frac{xd}{L}$	$c = 10^{-2}$ $\mu = 10^{-6}$	$m = 10^{-3}$ $n = 10^{-9}$



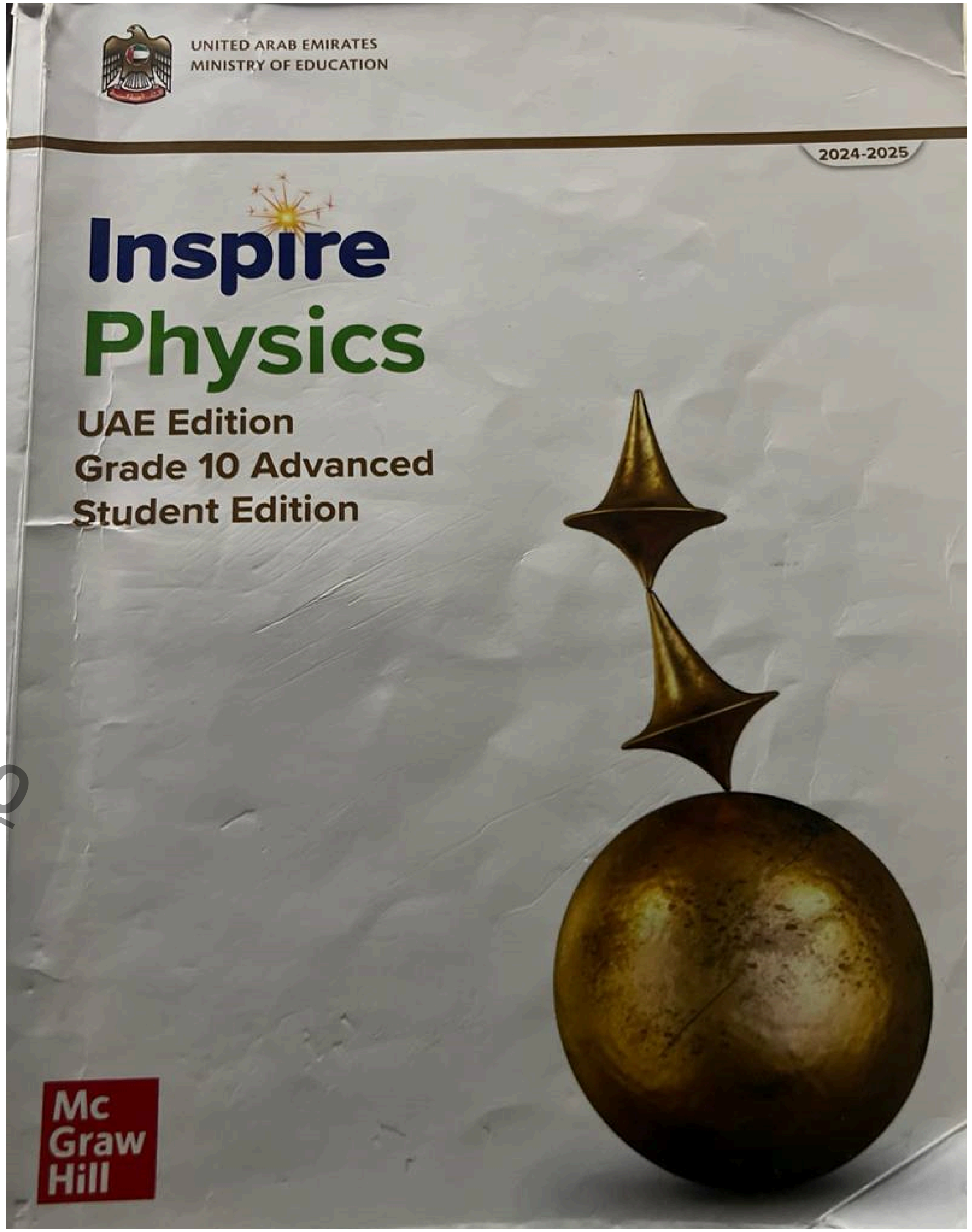
Whenever necessary, use the following physical formulas.
كلما كان ذلك ضروريا، استخدم الصيغ الفيزيائية التالية

Unit 6 (Module 21) Electromagnetism الكهرومغناطيسية	$EMF = BLv\sin(\theta)$ $I = \frac{EMF}{R}$ $P_{AC} = \frac{1}{2}P_{max}$ $I_{eff} = \left(\frac{\sqrt{2}}{2}\right) I_{max}$ $\lambda = \frac{v}{f} = \frac{c}{f}$	$P = \frac{(\Delta V)^2}{R}$ $(P_p = P_s)_{ideal\ transformer}$ $\frac{I_s}{I_p} = \frac{V_p}{V_s} = \frac{N_p}{N_s}$ $V_{eff} = \left(\frac{\sqrt{2}}{2}\right) V_{max}$ $v = \frac{c}{n} = \frac{c}{\sqrt{k}}$

Unit 7 (Module 17) Interference and Diffraction التداخل والحيود	$m\lambda = \frac{x_m d}{L},\ m = 0,1,2, ...$		$\lambda_{film} = \frac{\lambda_{vacuum}}{n_{film}}$
	Two-wave mode and interference type وضعية الموجة ونوع التداخل	One wave is inverted إحدى الموجتين مقلوبة	Either both waves OR none are inverted كلا الموجتين مقلوبة أو غير مقلوبة
	Constructive interference تداخل بناء	$2d = (m + \frac{1}{2})\lambda_{film}$ $m = 0, 1, 2, ...$	$2d = m\lambda_{film}$ $m = 1, 2, 3 ....$
	Destructive interference تداخل هدام	$2d = m\lambda_{film}$ $m = 1, 2, 3 ....$	$2d = (m + \frac{1}{2})\lambda_{film}$ $m = 0, 1, 2, ...$

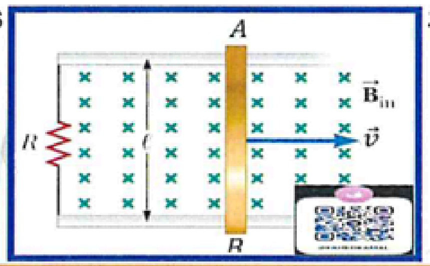
Whenever necessary, use the following physical constants.
كلما كان ذلك ضروريا، استخدم الثوابت الفيزيائية التالية

$c = 3 \times 10^8\ m/s$	$g = 9.81\ m/s^2$



Q1	1. Apply the equation EMF=BLv(sin θ) to determine the magnitude of induced emf for a wire moving through a magnetic field. 2. Apply the equation I=EMF/R to calculate the magnitude of induced current in a wire that is part of a closed circuit.	Student Book	P.(149 – 150)
		Q.(1 – 3)	P.151

A straight wire AB, 1.3 m long, moves at a constant speed of 6.0 m/s perpendicular to a magnetic field of strength 0.42 T. The wire is part of a circuit that has a resistance of = 3.0 Ω What is the current through the wire?



سلك مستقيم AB طوله 1.3 متر يتحرك بسرعة ثابتة 6 m/s بشكل عامودي على خطوط مجال مغناطيسي 0.42 T والسلك هو جزء من دائرة مقاومتها 3.0 Ω ما هو التيار المار بالسلك؟

....

....

....

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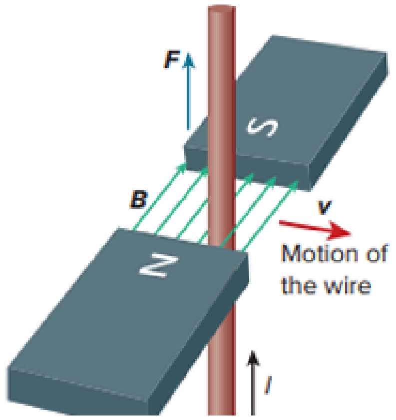
Induced *EMF* You don't need a chemical reaction in a battery to create an *EMF*. When a wire moves perpendicular to a magnetic field, there is a force on the charges in the wire. The force causes negative charges to move to one end of the wire, leaving positive charges at the other end. This separation of charge produces an electric field and therefore a potential difference across the length of the wire. This potential difference is called the **induced electromotive force,** or induced *EMF*.



. The force causes negative charges to move to one end of the wire, leaving positive charges at the other end. This separation of charge produces an electric field and therefore a potential difference across the length of the wire. This potential difference is called the **induced electromotive force,** or induced *EMF*.

$$\left(\frac{N}{A\cdot m}\right)(m)\left(\frac{m}{s}\right) = \frac{(N\cdot m)}{(A\cdot s)} = \frac{J}{C} = V$$

Induced Electromotive Force in a Wire

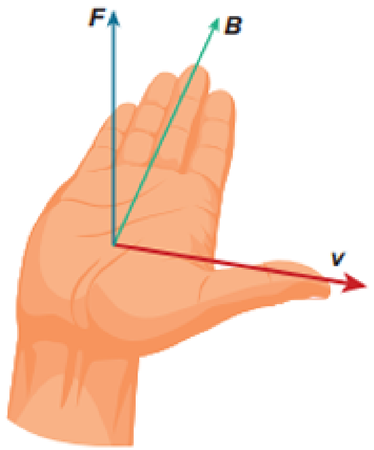
EMF is equal to the strength of the magnetic field times the length of the wire times the component of the velocity of the wire in the field that is perpendicular to the field.

$$EMF = BLv(\sin\theta)$$

$$I = \frac{EMF}{R}$$

If a wire moves perpendicular to a magnetic field, the above equation reduces to $EMF = BLv$, because $\sin 90° = 1$. Note that no *EMF* is induced in a length of wire that moves parallel to a magnetic field because $\sin 0° = 0$.

Right-Hand Rule



PRACTICE Problems ADDITIONAL PRACTICE

1. You move a straight wire that is 0.5 m long at a speed of 20 m/s vertically through a 0.4-T magnetic field pointed in the horizontal direction.
   a. What *EMF* is induced in the wire?
   b. The wire is part of a circuit with a total resistance of 6.0 Ω. What is the current?
2. A straight wire that is 25 m long is mounted on an airplane flying at 125 m/s. The wire moves in a perpendicular direction through Earth's magnetic field ($B = 5.0\times10^{-5}$ T). What *EMF* is induced in the wire?
3. A straight wire segment in a circuit is 30.0 m long and moves at 2.0 m/s perpendicular to a magnetic field.
   a. A 6.0-V *EMF* is induced. What is the magnetic field?
   b. The total resistance of the circuit is 5.0 Ω. What is the current?
4. **CHALLENGE** A horseshoe magnet is mounted so that the magnetic field lines are vertical. You pass a straight wire between the poles and pull it toward you. The current through the wire is from right to left. Which is the magnet's north pole? Explain.

تعليم

Q1	1. Apply the equation EMF=BLv(sin θ) to determine the magnitude of induced emf for a wire moving through a magnetic field. 2. Apply the equation I=EMF/R to calculate the magnitude of induced current in a wire that is part of a closed circuit.	Student Book	P.(149 – 150)
		Q.(1 – 3)	P.151

INDUCED *EMF* A straight wire is part of a circuit that has a resistance (R) of 0.50 Ω. The wire is 0.20 m long and moves at a constant speed of 7.0 m/s perpendicular to a magnetic field of strength 8.0×10^{-2} T.

a. What *EMF* is induced in the wire?

b. What is the current through the wire?

c. If a different metal were used for the wire, increasing the circuit's resistance to 0.78 Ω, what would the new current be?

Known	Unknown
$v = 7.0$ m/s	$EMF = ?$
$L = 0.20$ m	$I = ?$
$B = 8.0\times10^{-2}$ T	
$R_1 = 0.50\ \Omega$	
$R_2 = 0.78\ \Omega$	

2 SOLVE FOR THE UNKNOWN

a. $EMF = BLv$

$$= (8.0\times10^{-2}\ \text{T})(0.20\ \text{m})(7.0\ \text{m/s})$$
$$= 0.11\ \text{T}\cdot\text{m}^2/\text{s}$$
$$= 0.11\ \text{V}$$

b. $I = \frac{EMF}{R}$

$$= \frac{0.11\ \text{V}}{0.50\ \Omega}$$
$$= 0.22\ \text{A}$$

c. $I = \frac{EMF}{R}$

$$= \frac{0.11\ \text{V}}{0.78\ \Omega}$$
$$= 0.14\ \text{A}$$

A wire of length (0.18 m) moves at a constant speed perpendicular to a magnetic field of (0.4 T) and EMF of (0.60 V) generates in the wire .What is the speed of the wire?

يتحرك سلك طوله (0.18 m) بسرعة ثابتة بشكل متعامد على مجال مغناطيسي شدته (0.4 T) فيتولد فيه EMFمقدارها (0.60 V) ما سرعة حركة السلك ؟

A	2.0 m/s	B	3.8 m/s
C	8.3 m/s	D	10 m/s

A **15 cm** length of wire is moving perpendicularly through a magnetic field of strength **1.4 T** at the rate of **0.12 m/s**. What is the *EMF* induced in the wire ?

يتحرك سلك طوله (15 cm) عمودياً عبر مجال مغناطيسي مقداره (1.4 T) بسرعة (0.12 m/s) . فإن EMF المستحثة في السلك ؟

A	0 V	B	0.025 V	C	0.018 V	D	2.5 V

A straight wire is part of a circuit that has a resistance (R) of 0.50 Ω. The wire is 0.20 m long and moves at a constant speed of 7.0 m/s perpendicular to a magnetic field of strength 8.0×10^{-2} T .What *EMF* is induced in the wire

سلك مستقيم يمثل ً جزءا من دائرة بمقاومة(R) تبلغ 0.50 Ω يبلغ طول السلك 0.20 m ويتحرك بسرعة ثابتة تبلغ ً 7.0 m/s عموديا على مجال مغناطيسي مقداره 8.0×10^{-2} T ما مقدارEMF المستحثة في السلك

A	1.1 V	B	0.11 N
C	11 V	D	0.11 V

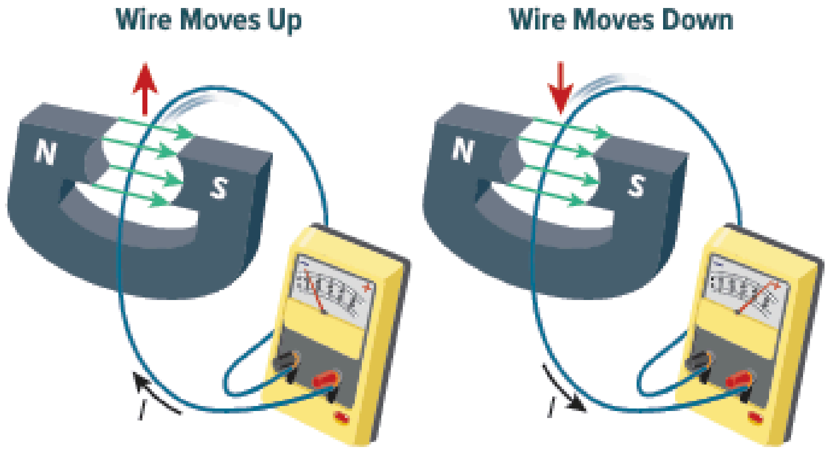
LUAY ATA 0505369567

Q2	Part A: Define electromagnetic induction, identify its types, self-induction and mutual induction, and relate them to Faraday's law of electromagnetic induction.	Student Book	P.(148, 159 – 160) P.161 P.(148 – 149)
	Part B: Differentiate between step-up and step-down transformers.	Q.11; Q.(18-20)	P.155; P.163
	Part C: Explain how the relative motion between a conductor such as a wire and a magnetic field causes an induced emf.	Table "CONNECTING MATH to Physics"); Q.(20 – 23) Q.4	P.163 P.151

Changing Magnetic Fields

Following Oersted's discovery that a current produces a magnetic field, Michael Faraday became convinced the reverse was possible: that a magnetic field could produce a current. In 1822 he wrote this goal in his notebook: "Convert magnetism into electricity." After ten years of unsuccessful experiments, he succeeded. He induced a current in a circuit by moving a wire through a magnetic field. In the same year in America, Joseph Henry, a high-school teacher who later became the first secretary of the Smithsonian Institution, made the same discovery. **Figure 1** illustrates a modern version of one of Faraday's and Henry's experiments.

Relative motion An electric current can be generated in a wire in a circuit when at least part of the wire moves through, and cuts, magnetic field lines. Field lines can be cut when a segment of wire moves through a stationary magnetic field, as the wire does in **Figure 1.** Field lines also can be cut when a magnetic field moves past a stationary wire or when the strength of a magnetic field changes around a wire. **Electromagnetic induction** is the process of generating current through a wire in a circuit in a changing magnetic field.



Defined :
Electromagnetic induction:

عرف :
الحث الكهرومغناطيسي

....

....

....

Q2	Part A: Define electromagnetic induction, identify its types, self-induction and mutual induction, and relate them to Faraday's law of electromagnetic induction.	Student Book	P.(148, 159 – 160) P.161 P.(148 – 149)
	Part B: Differentiate between step-up and step-down transformers.	Q.11; Q.(18-20)	P.155; P.163
	Part C: Explain how the relative motion between a conductor such as a wire and a magnetic field causes an induced emf.	Table "CONNECTING MATH to Physics"); Q.(20 – 23)	P.163
		Q.4	P.151

Self-inductance An *EMF* can be induced in a wire when the magnetic field in the region of the wire changes. The field can be external, or it can be generated by the current in the wire itself, as in **Figure 13.**

Figure 12 An EMF is induced in both aluminum rings, but current is produced only in the continuous ring because only this ring completes a circuit. Thus, only this ring experiences a force, and only this ring levitates. If the rings were made from a nonconducting material, such as nylon or wood, an EMF would not be induced in either one.

Imagine that the coil of wire in **Figure 13** is suddenly connected to a battery. This causes a change in the potential difference across the coil, producing a changing current through the coil. The changing current generates a changing magnetic field in the coil. This changing field induces an *EMF* in the direction that opposes the change. The induced *EMF* reduces the potential difference across the coil. The result is a net decrease in current.

Therefore, initially the current through the coil is small but increasing. However, as the rate of change of current decreases, so does the opposing *EMF.* When the current reaches a constant final value, the current change is zero, so the induced *EMF* is also zero.

If the potential difference supplied by a battery is decreased, the current is also decreased. So, the induced *EMF* changes to be in a direction to maintain the magnetic field. Therefore, the induced current is in the same direction as the current from the battery. If the coil were suddenly disconnected from the battery, the induced *EMF* could be large enough to produce a spark. The property of a wire, either straight or in a coil, to create an induced *EMF* that opposes the change in the potential difference across the wire is called **self-inductance.**

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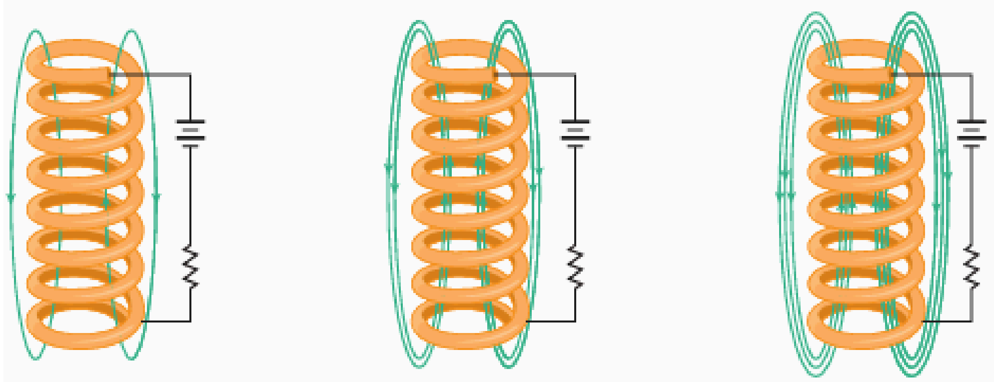

Figure 13 As the current in the coil increases, the magnetic field generated by the current also increases. The increase in the magnetic field induces an EMF that opposes the direction of current, and more energy is needed to increase the current further.

Transformers

You have probably seen metal cylinders attached to utility poles, such as the cylinders on the pole in **Figure 14.** Inside each of these cylinders is a transformer. **Transformers** are devices that increase or decrease potential differences with relatively little waste of energy. Only alternating current (AC) can be sent through a transformer. Direct current (DC) cannot pass through a transformer.

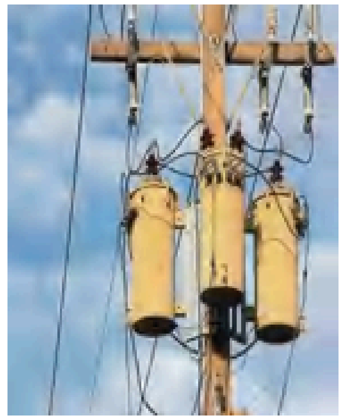

Figure 14 Inside these cylinders are transformers. Transformers reduce high voltages to usable levels before the electrical energy enters your home.

How transformers work You read that self-inductance produces an *EMF* when current changes in a single coil. A transformer has two coils, electrically insulated from each other but wound around the same iron core, as you can see in **Figure 15.** When one coil—the primary coil—is connected to an AC source, the changing current creates a changing magnetic field that is carried through the core to the other coil—the secondary coil. In the secondary coil, the changing magnetic field induces a varying *EMF* and current. An *EMF* and current in one coil due to changing current in another coil is called **mutual inductance.**

The *EMF* induced in the secondary coil, called the secondary potential difference, is proportional to the potential difference provided to the primary coil. The secondary potential difference also depends on what is called the turns ratio. The turns ratio is the number of turns of wire in the secondary coil divided by the number of turns in the primary coil, as shown on the right in the following expressions.

$$\frac{\text{primary potential difference}}{\text{secondary potential difference}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$$

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

If the secondary potential difference is larger than the primary potential difference, as it is in the left part of **Figure 15,** the transformer is called a **step-up transformer.** If the secondary potential difference is smaller than the primary potential difference, as in the right part of **Figure 15,** the transformer is called a **step-down transformer.**

Get It?

Compare How do step-up transformers differ from step-down transformers?

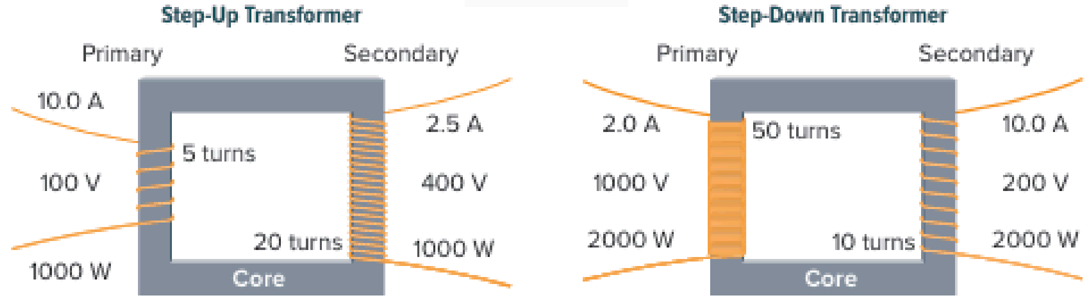

Figure 15 The ratio of primary potential difference to secondary potential difference in a transformer depends on the

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Transformer Equation

The ratio of the current in the secondary coil to the current in the primary coil is equal to the ratio of the potential difference in the primary coil to the potential difference in the secondary coil, which is also equal to the ratio of the number of turns on the primary coil to the number of turns on the secondary coil.

$$\frac{I_s}{I_p} = \frac{V_p}{V_s} = \frac{N_p}{N_s}$$

Step-Up Transformer	Step-Down Transformer
$V_p < V_s$	$V_p > V_s$
$I_p > I_s$	$I_p < I_s$
$N_p < N_s$	$N_p > N_s$

Q2	Part A: Define electromagnetic induction, identify its types, self-induction and mutual induction, and relate them to Faraday's law of electromagnetic induction.	Student Book	P.(148, 159 – 160) P.161 P.(148 – 149)
	Part B: Differentiate between step-up and step-down transformers.	Q.11; Q.(18-20)	P.155; P.163
	Part C: Explain how the relative motion between a conductor such as a wire and a magnetic field causes an induced emf.	Table "CONNECTING MATH to Physics"); Q.(20 – 23)	P.163
		Q.4	P.151

Effective Potential Difference

Effective potential difference is equal to $\frac{\sqrt{2}}{2}$ times the maximum potential difference.

$$V_{eff} = \left(\frac{\sqrt{2}}{2}\right)V_{max} = 0.707V_{max}$$

Effective Current

Effective current is equal to $\frac{\sqrt{2}}{2}$ times the maximum current.

$$I_{eff} = \left(\frac{\sqrt{2}}{2}\right)I_{max} = 0.707I_{max}$$

$$P_{AC} = \frac{1}{2}P_{AC\ max}.$$

11. **Bike Generator** A small generator on your bike lights the bike's headlight. What is the source of the energy for the bulb when you ride along a flat road?

is the current?

4. **CHALLENGE** A horseshoe magnet is mounted so that the magnetic field lines are vertical. You pass a straight wire between the poles and pull it toward you. The current through the wire is from right to left. Which is the magnet's north pole? Explain.

18. **Lenz's Law** You hang a coil of wire with its ends joined so that it can swing easily. If you now plunge a magnet into the coil, the coil will start to swing. Which way will it swing relative to the magnet and why?

19. **Motors** If you unplugged a running vacuum cleaner from a wall outlet, you would be much more likely to see a spark than you would if you unplugged a lighted lamp from the wall. Why?

20. **Transformers and Current** Explain why a transformer may be operated only on AC.

21. **Transformers** Frequently, transformer coils that have only a few turns are made of very thick (low-resistance) wire, while those with many turns are made of thin wire. Why?

22. **Step-Up Transformers** Refer to the step-up transformer shown in **Figure 15.** Explain what would happen to the primary current if the secondary coil were short-circuited.

23. **Critical Thinking** Would permanent magnets make good transformer cores? Explain.

Q3	Part A: Define electromagnetic induction, identify its types, self-induction and mutual induction, and relate them to Faraday's law of electromagnetic induction.	Student Book	P.(156 – 157) P.(154, 157 – 159)
	Part B: 1. Describe how Lenz's Law affects the operation of electric motors and generators. 2. Describe magnetic levitation and the braking effect through eddy currents as applications on Lenz's Law. 3. Differentiate between AC and DC currents	Figure 10 (Apply); Q.18 All Terms / Concepts	P.157; P.163 P.(154, 157 – 159)

Lenz's Law

Imagine the hand pulling the wires through the magnetic field in **Figure 9** is yours. As you pull, the movement of the wire induces an *EMF*. The wire slides on the wire loop, making a complete circuit, so the *EMF* produces a current. Because the magnetic field (B) is out of the page and the velocity is to the right, the right-hand rule shows that the direction of current in the wire is downward and clockwise in the circuit.

Opposing motion The downward-moving charges in the wire moving through the magnetic field that is out of the page experience a force. The right-hand rule shows that the direction of this force is opposite the movement of the wire. These charges exert a force on the wire that opposes the motion of the wire and makes it harder for you to pull it. The physicist H.F.E. Lenz first demonstrated this force in 1834.

Opposing change While Lenz stated his law in terms of force, there is a second way of interpreting it. The current in the loop produces its own magnetic field. The right-hand rule shows that the direction of this induced field inside the loop is into the paper. That is, it is in the direction that opposes the change in the field that caused it. Thus, **Lenz's law** says that the magnetic field produced by an induced current is in the direction that is opposite to the change in the original field.

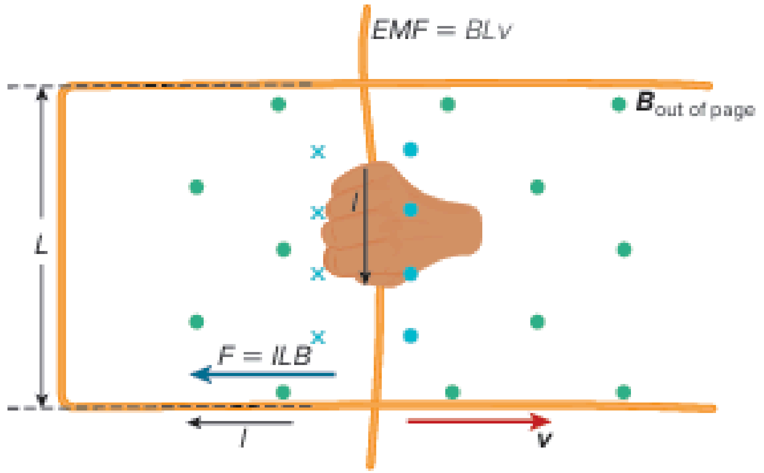
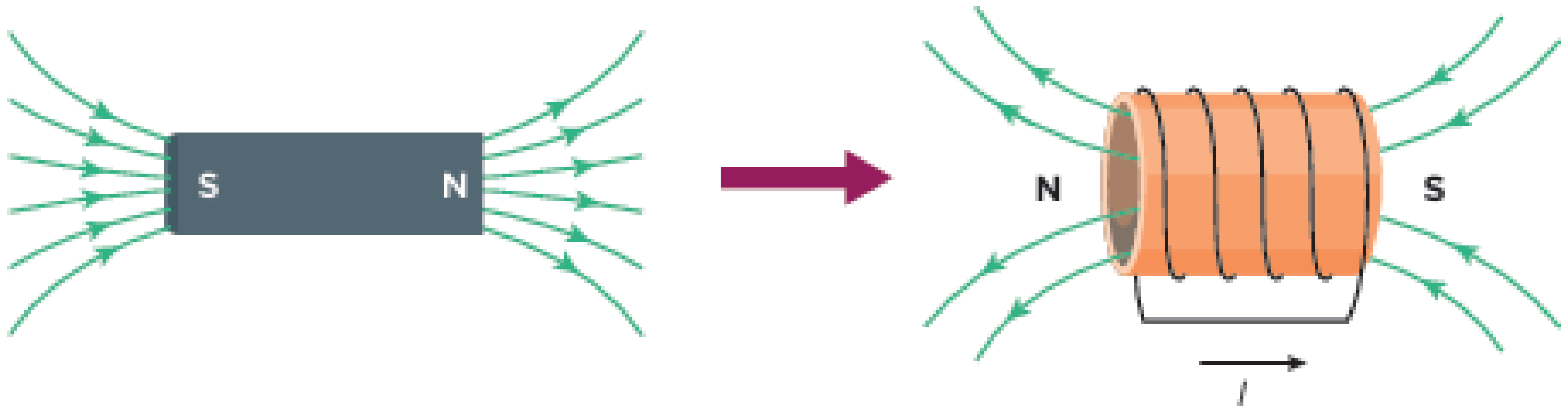
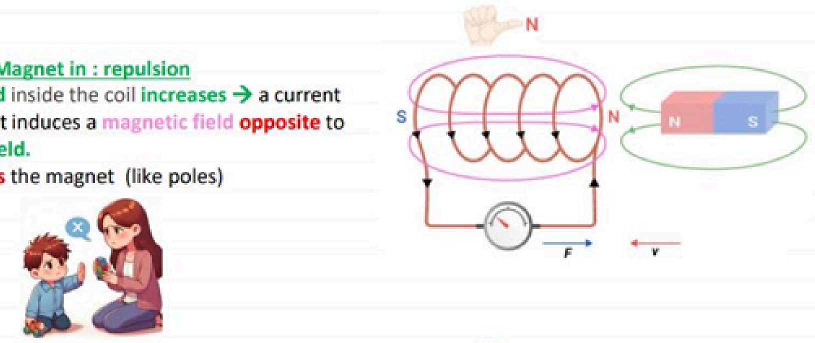


Figure 9 A wire pulled through a magnetic field generates an *EMF*. The *EMF* produces a current in the circuit (I). Motion of the charges in the wire produces a force (F). The current also produces a magnetic field (blue dots and crosses) that, within the loop, is in the direction opposite that of the change in the field which caused it.



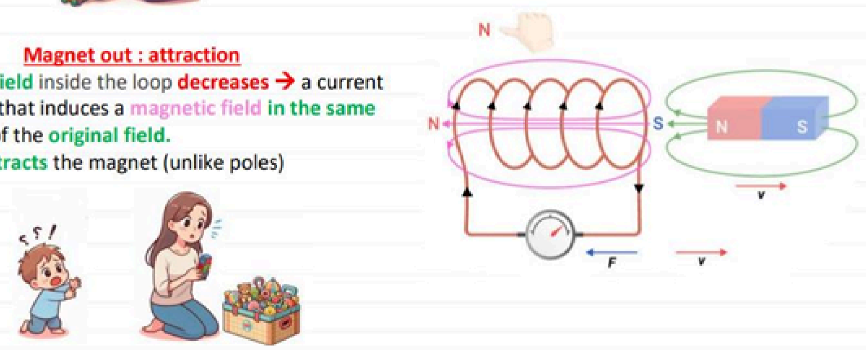
Magnet in : repulsion

- magnetic field inside the coil increases → a current is induced that induces a magnetic field opposite to the original field.
- The coil repels the magnet (like poles)

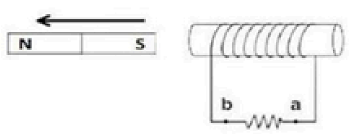


Magnet out : attraction

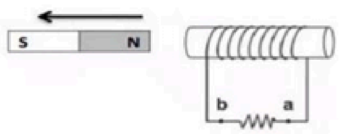
- magnetic field inside the loop decreases → a current is induced that induces a magnetic field in the same direction of the original field.
- The coil attracts the magnet (unlike poles)



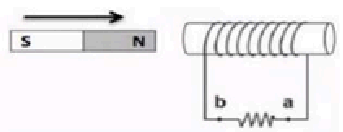
Ministry: specify the direction of the current :



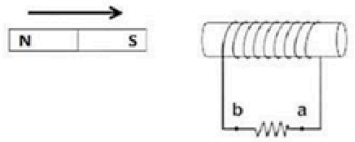
Ministry: specify the direction of the current :



Ministry: specify the direction of the current :

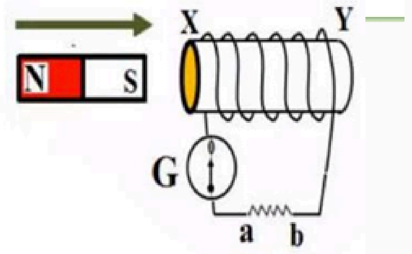


Ministry: specify the direction of the current :

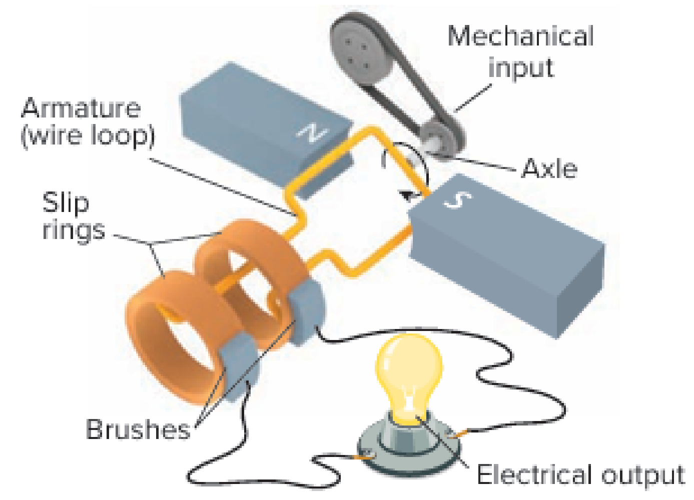


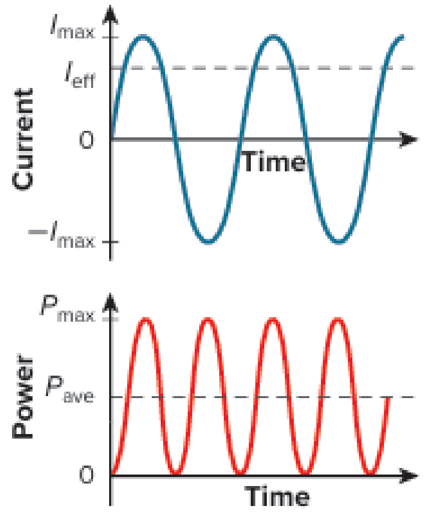
Ministry:

1. what are the poles induced on the solenoid?
2. Specify the direction of the induced current, what is the name of the rule you used?
3. What happens to the deflection of the galvanometer's needle in the following cases:
   - moving the magnet quicker
   - putting an iron core in the solenoid
4. What is the direction of the current , when the magnet is pulled away?

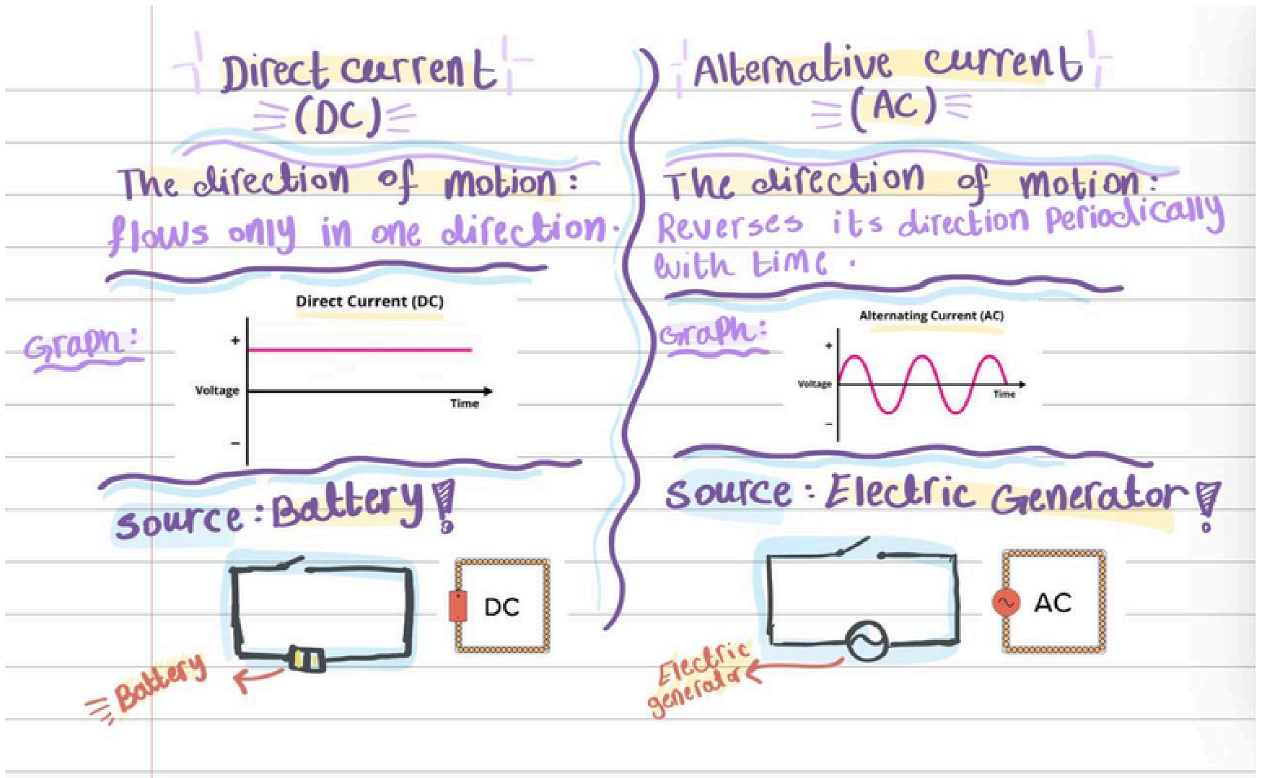


Q3	Part A: Define electromagnetic induction, identify its types, self-induction and mutual induction, and relate them to Faraday's law of electromagnetic induction.	Student Book	P.(156 – 157) P.(154, 157 – 159)
	Part B: 1. Describe how Lenz's Law affects the operation of electric motors and generators. 2. Describe magnetic levitation and the braking effect through eddy currents as applications on Lenz's Law. 3. Differentiate between AC and DC currents	Figure 10 (Apply); Q.18 All Terms / Concepts	P.157; P.163 P.(154, 157 – 159)

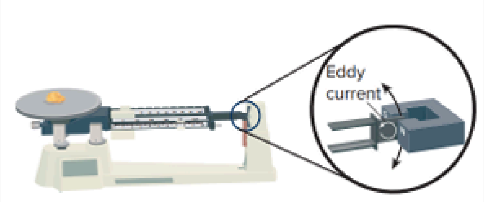




Average power The power produced by an AC generator is the product of the current and the potential difference. Because both current and potential difference vary, the power in the circuit varies. The graph at the bottom right of **Figure 8** shows the power versus time produced by an AC generator. Note that power is always positive because I and V are either both positive or both negative. Average power, P_{AC}, is half the maximum power; thus, $P_{AC} = \frac{1}{2}P_{AC\ max}$.



Eddy currents are currents generated in any piece of metal moving through a magnetic field; the magnetic field they produce opposes the motion that caused the currents. The force on the metal opposes the motion of the metal in either direction, but it does not act when the metal is still. Thus, it does not change measurements of the mass of an object on the pan.



The property of a wire, either straight or in a coil, to create an induced *EMF* that opposes the change in the potential difference across the wire is called **self-inductance.**

ماذا نسمي الخاصية التي تنشأ في السلك، حيث تتولد (EMF) مُستحثه وتيار مُستحث يقاوم التغير في فرق الجهد بين طرفي السلك؟

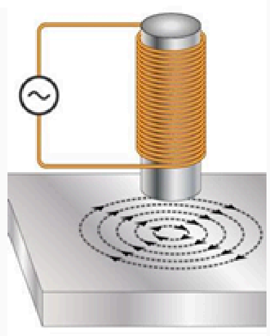
What do we call the property of a wire, to create an induced (EMF) that opposes the change in the potential difference across it?

Levitation.	التعليق	Self -Induction	الحث الذاتي
Effective Current	التيار الفعال	Mutual -Induction	الحث المتبادل

Levitation caused by repulsion underlies the operation of very fast trains called magnetic levitation (Maglev) trains.

What is the best explanation of the current in the grey mineral block below the electromagnet?

- The current creates an electromagnet above it.
- It is an eddy current that forms in the magnet.
- It is an eddy current that forms in solid metal.
- The electromagnet above provides a constant magnetic field.



Q4	Part A: 1. Apply the relation (λ=xd/L) to calculate the wavelength or to find an unknown distance in a double-slit investigation given the other values. 2. Show that the intensity of bright bands decreases as you go farther from the central band (double slit interference with monochromatic light). 3. Explain the formation of a colored spectra when white light is used in a double-slit investigation.	Student Book	P. (191 – 192) P.(200 – 202)
	Part B: Explain how optical discs act as diffraction gratings, and using the constructive interference equation (mλ= dsinθ where m=1,2,3..) in a diffraction grating to calculate the wavelength of light.	Q.(1 – 4) Q.(20 – 24)	P.192 P.203

Constructive التداخل البناء Interference	Destructive التداخل الهدام Interference
$\frac{m\lambda}{d}=\frac{x}{L}$	$\frac{(m-\frac{1}{2})\lambda}{d}=\frac{x}{L}$

Coherent Light

light made up of waves of the same wavelength that are in phase with each other.

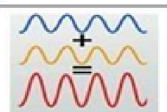
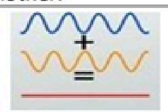
Example: laser

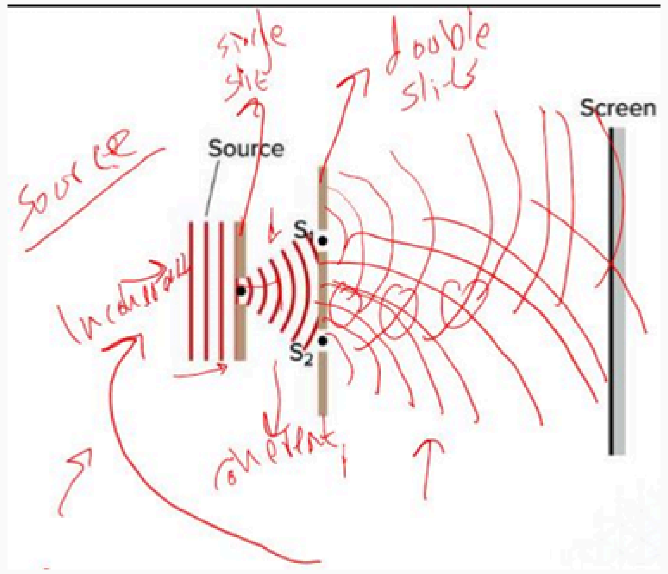
Incoherent Light

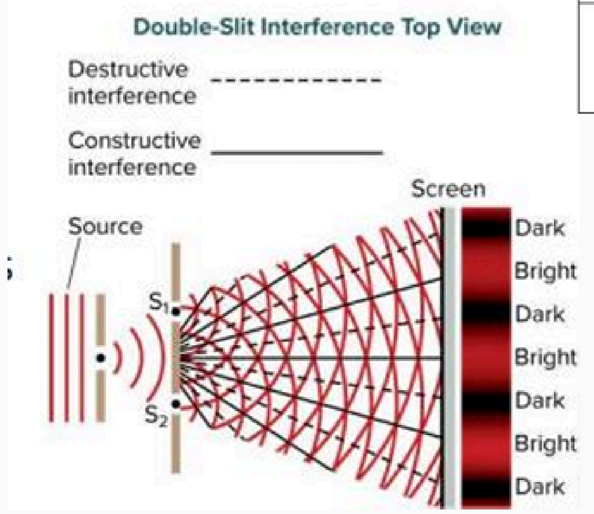
Incoherent light is light whose waves are not in phase, such as white light from a light bulb.

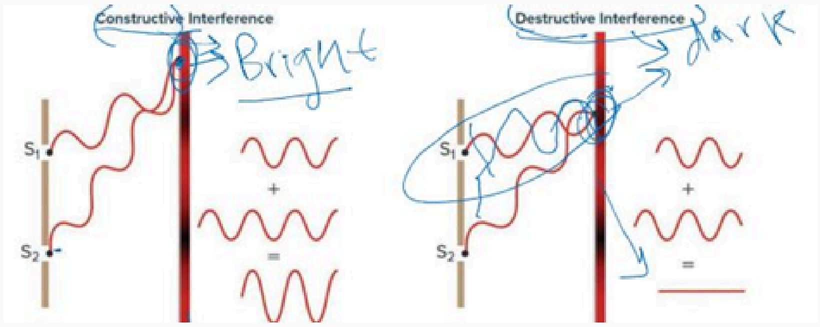
Example: light bulb

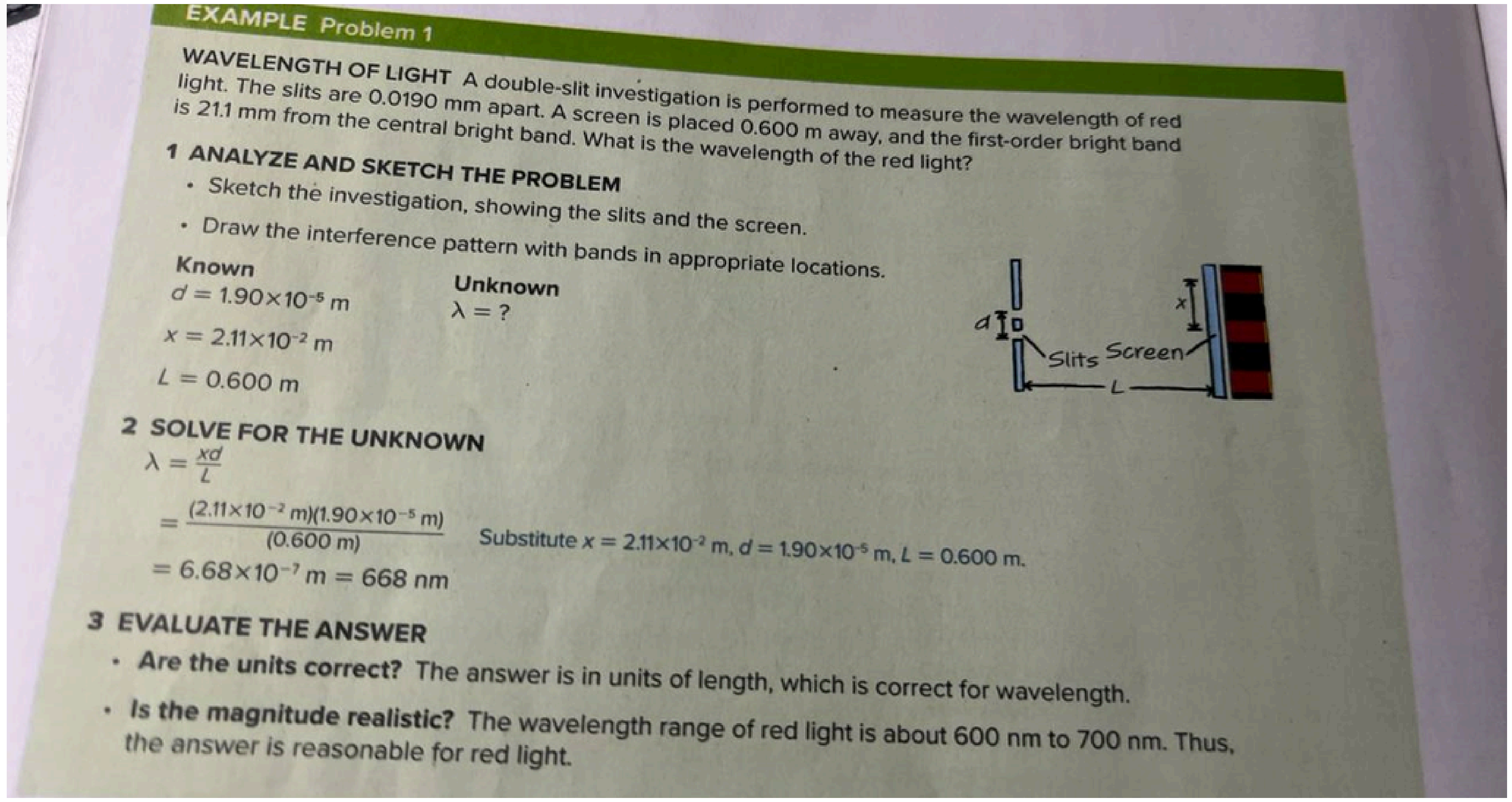
pattern of light and dark bands called interference fringes.

Constructive	Destructive
When two waves meet in such a way that their crests line up together.	When two waves meet in such a way that the crest of one wave meets the trough of another.
	









EXAMPLE Problem 1

WAVELENGTH OF LIGHT A double-slit investigation is performed to measure the wavelength of red light. The slits are 0.0190 mm apart. A screen is placed 0.600 m away, and the first-order bright band is 21.1 mm from the central bright band. What is the wavelength of the red light?

1 ANALYZE AND SKETCH THE PROBLEM
- Sketch the investigation, showing the slits and the screen.
- Draw the interference pattern with bands in appropriate locations.

Known
$d = 1.90\times10^{-5}$ m
$x = 2.11\times10^{-2}$ m
$L = 0.600$ m

Unknown
$\lambda = ?$

2 SOLVE FOR THE UNKNOWN

$$\lambda = \frac{xd}{L}$$

$$= \frac{(2.11\times10^{-2}\text{ m})(1.90\times10^{-5}\text{ m})}{(0.600\text{ m})}$$ Substitute $x = 2.11\times10^{-2}$ m, $d = 1.90\times10^{-5}$ m, $L = 0.600$ m.

$$= 6.68\times10^{-7}\text{ m} = 668\text{ nm}$$

3 EVALUATE THE ANSWER
- **Are the units correct?** The answer is in units of length, which is correct for wavelength.
- **Is the magnitude realistic?** The wavelength range of red light is about 600 nm to 700 nm. Thus, the answer is reasonable for red light.

Q4	Part A: 1. Apply the relation (λ=xd/L) to calculate the wavelength or to find an unknown distance in a double-slit investigation given the other values. 2. Show that the intensity of bright bands decreases as you go farther from the central band (double slit interference with monochromatic light). 3. Explain the formation of a colored spectra when white light is used in a double-slit investigation.	Student Book	P. (191 – 192) P.(200 – 202)
	Part B: Explain how optical discs act as diffraction gratings, and using the constructive interference equation (mλ= dsinθ where m=1,2,3..) in a diffraction grating to calculate the wavelength of light.	Q.(1 – 4) Q.(20 – 24)	P.192 P.203

1- Define the diffraction grating

A diffraction grating is a device made up of many single slits that diffract light and form a diffraction pattern that is an overlap of single slit diffraction patterns.

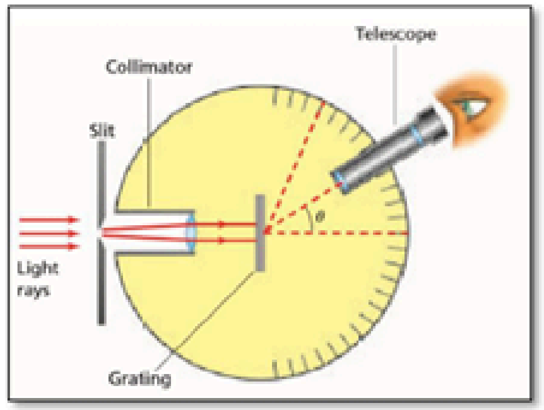
2- What is the purpose of using diffraction grating?

When we use the diffraction grating, we get a pattern that is similar to that of two-slits interference pattern but with much narrower and brighter bands that makes measuring the wavelength more accuracy.

$$\boxed{m\lambda = d \sin\theta_m}$$

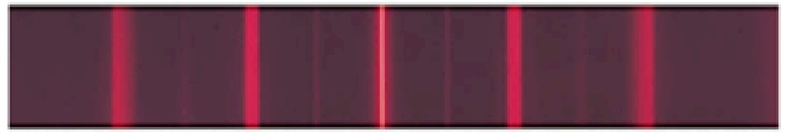
$$m = 0,1,2,3,4$$

4- What is the name of the device that measuring the wavelength of the light using the diffraction grating?



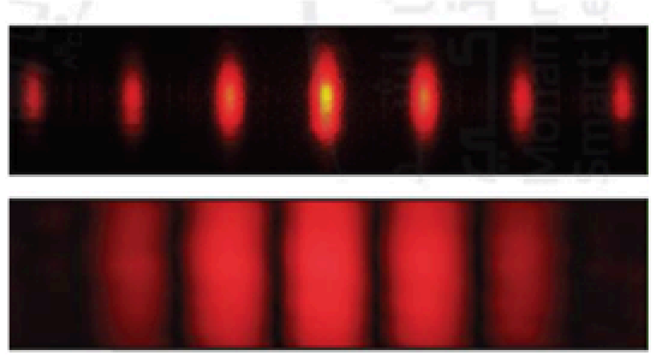
The grating spectroscope, the grating produces a diffraction pattern that is viewed through a telescope.

5- Describe the pattern of the diffraction grating.



- Narrow central bright band
- Narrow bright bands on the either sides of the central bright band
- Dark areas between the bright bands
- The separation distances between the bright bands are equal

Note: you can compare between the pattern of double slits and the diffraction grating patterns in this figure.



Q4	Part A: 1. Apply the relation ($\lambda = xd/L$) to calculate the wavelength or to find an unknown distance in a double-slit investigation given the other values. 2. Show that the intensity of bright bands decreases as you go farther from the central band (double slit interference with monochromatic light). 3. Explain the formation of a colored spectra when white light is used in a double-slit investigation.	Student Book	P. (191 – 192) P.(200 – 202)
		Q.(1 – 4)	P.192
	Part B: Explain how optical discs act as diffraction gratings, and using the constructive interference equation ($m\lambda = d\sin\theta$ where m=1,2,3..) in a diffraction grating to calculate the wavelength of light.	Q.(20 – 24)	P.203

PRACTICE Problems

1. Violet light falls on two slits separated by 1.90×10^{-5} m. A first-order bright band appears 13.2 mm from the central bright band on a screen 0.600 m from the slits. What is λ?
2. Yellow-orange light of wavelength 596 nm from a sodium lamp is aimed at two slits that are separated by 1.90×10^{-5} m. What is the distance from the central band to the first-order yellow band if the screen is 0.600 m from the slits?

ADDITIONAL PRACTICE

3. In a double-slit investigation, physics students use a laser with $\lambda = 632.8$ nm. A student places the screen 1.000 m from the slits and finds the first-order bright band 65.5 mm from the central line. What is the slit separation?
4. **CHALLENGE** Yellow-orange light with a wavelength of 596 nm passes through two slits that are separated by 2.25×10^{-5} m and makes an interference pattern on a screen. If the distance from the central line to the first-order yellow band is 2.00×10^{-2} m, how far is the screen from the slits?

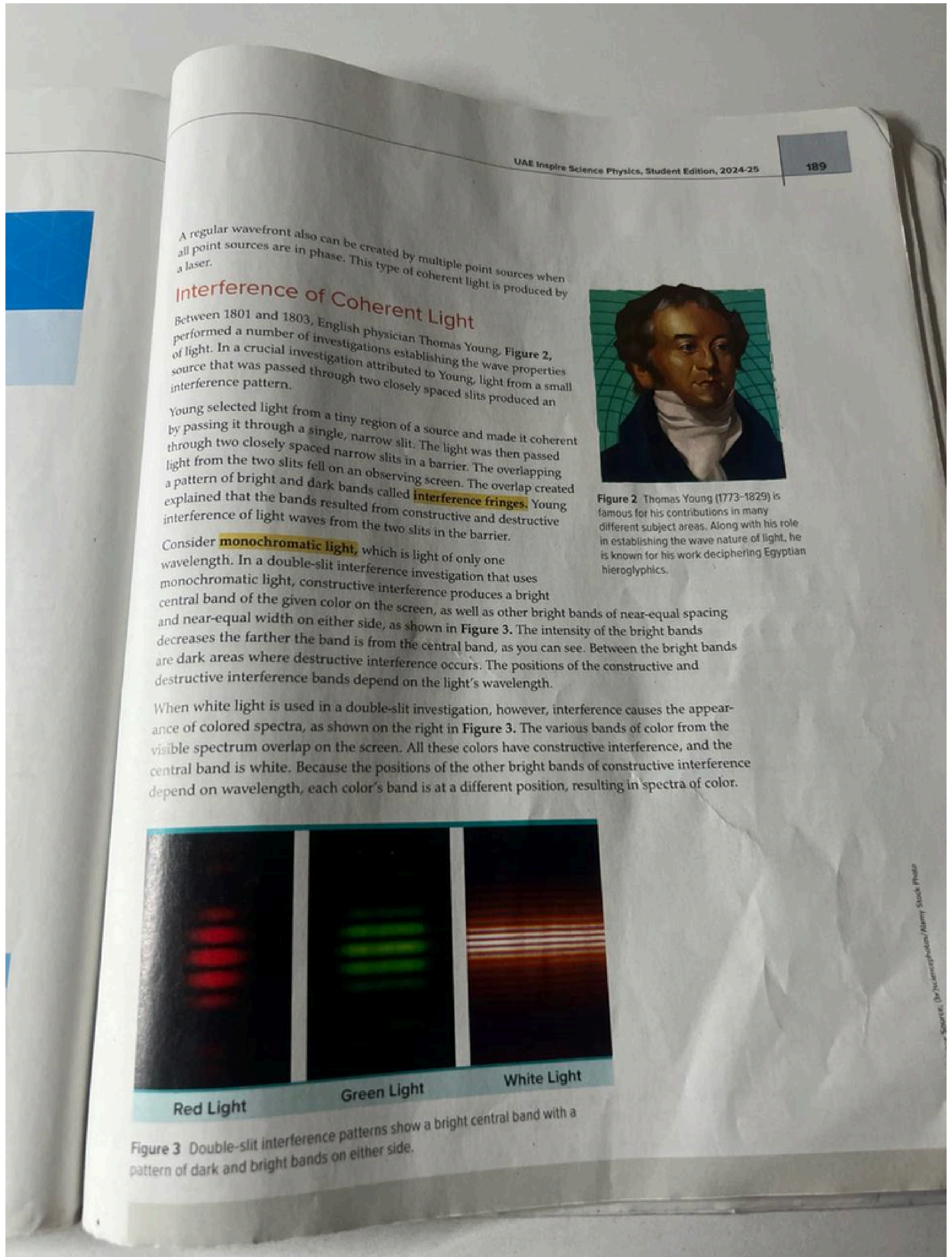
PRACTICE Problems

20. White light shines through a grating onto a screen. Describe the pattern that is produced.
21. If blue light of wavelength 434 nm shines on a diffraction grating and the spacing of the resulting lines on a screen that is 1.05 m away is 0.55 m, what is the spacing between the slits in the grating?
22. A diffraction grating with slits separated by 8.60×10^{-7} m is illuminated by violet light with a wavelength of 421 nm. If the screen is 80.0 cm from the grating, what is the separation of the lines in the diffraction pattern?

ADDITIONAL PRACTICE

23. For the DVD in Example Problem 3, suppose now that blue light shines on it. If the spots produced on a wall are separated by 58.0 cm, what is the wavelength of the light? The wall is 0.65 m away.
24. **CHALLENGE** Light of wavelength 632 nm passes through a diffraction grating and creates a pattern on a screen that is 0.55 m away. If the first bright band is 5.6 cm from the central bright band, how many slits per centimeter does the grating have?

Q5	Part A: 1. Explain how bright and dark interference fringes are created in a double-slit interference investigation with monochromatic light. 2. Recall the concepts of constructive and destructive interference and define interference fringes of light. Part B: Define coherent and incoherent light.	Student Book	P.(189 – 190) P.188
		Figure 5 Figure 1	P.190 P.188



A regular wavefront also can be created by multiple point sources when all point sources are in phase. This type of coherent light is produced by a laser.

Interference of Coherent Light

Between 1801 and 1803, English physician Thomas Young, Figure 2, performed a number of investigations establishing the wave properties of light. In a crucial investigation attributed to Young, light from a small source that was passed through two closely spaced slits produced an interference pattern.

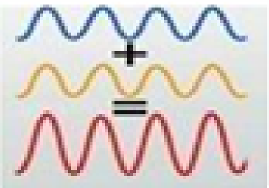
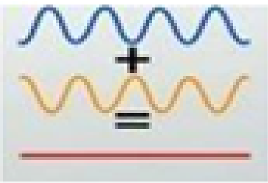
Young selected light from a tiny region of a source and made it coherent by passing it through a single, narrow slit. The light was then passed through two closely spaced narrow slits in a barrier. The overlapping light from the two slits fell on an observing screen. The overlap created a pattern of bright and dark bands called interference fringes. Young explained that the bands resulted from constructive and destructive interference of light waves from the two slits in the barrier.

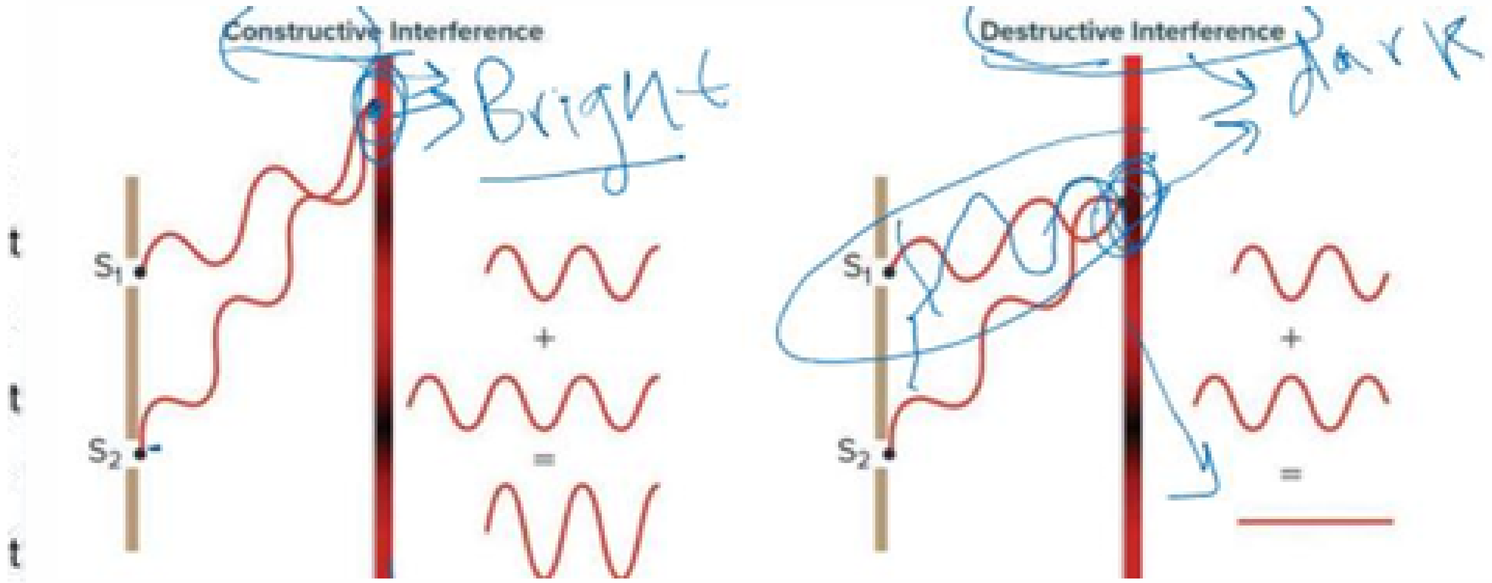
Figure 2 Thomas Young (1773–1829) is famous for his contributions in many different subject areas. Along with his role in establishing the wave nature of light, he is known for his work deciphering Egyptian hieroglyphics.

Consider monochromatic light, which is light of only one wavelength. In a double-slit interference investigation that uses monochromatic light, constructive interference produces a bright central band of the given color on the screen, as well as other bright bands of near-equal spacing and near-equal width on either side, as shown in Figure 3. The intensity of the bright bands decreases the farther the band is from the central band, as you can see. Between the bright bands are dark areas where destructive interference occurs. The positions of the constructive and destructive interference bands depend on the light's wavelength.

When white light is used in a double-slit investigation, however, interference causes the appearance of colored spectra, as shown on the right in Figure 3. The various bands of color from the visible spectrum overlap on the screen. All these colors have constructive interference, and the central band is white. Because the positions of the other bright bands of constructive interference depend on wavelength, each color's band is at a different position, resulting in spectra of color.

Figure 3 Double-slit interference patterns show a bright central band with a pattern of dark and bright bands on either side.

Constructive	Destructive
When two waves meet in such a way that their crests line up together.	When two waves meet in such a way that the crest of one wave meets the trough of another.
	



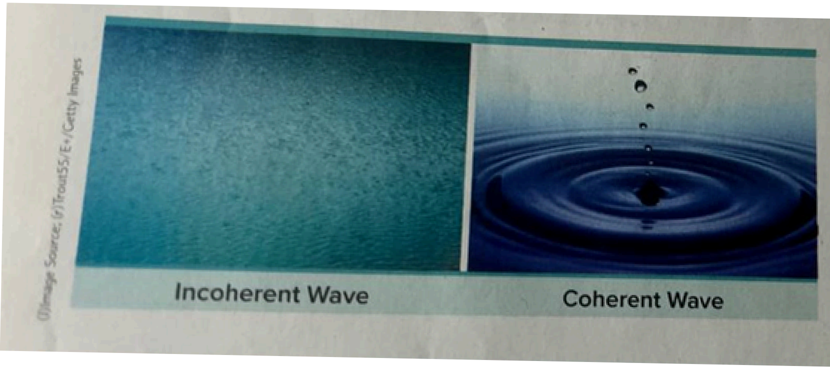


Figure 1 Choppy, irregular wave patterns model incoherent light. Regular wave patterns model coherent light.